DOCUMENT RESUME

ED 062 673 CG 007 245

AUTHOR	Follettie, Joseph F.
TITLE	Olson's "Cognitive Development": A Commentary.
INSTITUTION	Southwest Regional Educational Lab., Inglewood, Calif.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	Apr 72
NOTE	63p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Behavioral Science Research; *Book Reviews; Cognitive Ability; *Cognitive Development; *Cognitive Measurement; *Learning Processes

ABSTRACT

This report is a review of Olson's "Cognitive Development." Unlike a typical book review it does not compare and contrast the author's theoretical framework and methodological practices with those of others in the field, but rather it extensively describes and critiques the reported empirical work. The reasons given for this approach are that Olson's empirical practices are of interest in their own right, and alternative interpretations sometimes arise from a careful reading of Olson's procedures. "Cognitive Development" bears on a variety of issues germane to the design and development of instructional systems. Olson extensively studied the concept of diagonality using American and Canadian children aged 3 to 6, whose acquisition of the concept was compared with that of Kenyon children of two tribes, aged 5 to 13. A subject typically was required to construct a discretely-formed diagonal on a matrix, under various antecedent and criterion conditions. Olson describes findings in the context of relevant literature. (BW/Author)

OE-NCERD
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BR 6-2865

SWRL

SOUTHWEST REGIONAL LABORATORY FOR EDUCATIONAL RESEARCH & DEVELOPMENT

Olson's Cognitive Development: A Commentary

TR41 24 APRIL 1972

SOUTHWEST REGIONAL LABORATORY
TECHNICAL REPORT 41
APRIL 1972

OLSON'S COGNITIVE DEVELOPMENT: A COMMENTARY

Joseph F. Follettie

ABSTRACT

Olson's Cognitive Development bears on a variety of issues germane to the design and development of instructional systems. The book is reviewed in depth, with an emphasis on describing and critiquing the extensive empirical effort that Olson reports, the methodological orientation underlying this effort, and the theoretical position reached in consequence of it.

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The typical book review compares and contrasts the author's theoretical framework and methodological practices with those of others in the field. Perhaps because review space (and patience) is limited, the reviewer seldom describes and critiques reported empirical work in detail. A large component of Olson's Cognitive Development reports on interrelated experiments. These experiments will be described and commented on extensively for two reasons: a) Olson's empirical practices are of interest in their own right, and b) alternative interpretations sometimes arise from a careful reading of Olson's procedures.

A preponderance of research on conceptual skills classes under the headings of concept learning and cognitive development. From an instructional systems design standpoint, much of the concept learning research is of little interest because it addresses concept identification rather than concept formation tasks; much of the cognitive development research is of minimal interest because it focuses on in vacuo-emergent rather than on formally-instructed skills. Olson is an exception on both counts.

Olson extensively studied the concept of diagonality using American and Canadian children aged 3 to 6, whose acquisition of the concept was compared with that of Kenyan children of two tribes, aged 5 to 13. A subject typically was required to construct a discretely-formed diagonal on a five-rows-by-five-columns matrix, under various antecedent and criterion conditions. Olson describes several experiments--herein denoted A through K--and discusses findings in the context of relevant literature. His work stems from a preliminary finding that a "bright 5-year-old" could not reproduce a five-bulb diagonal pattern on a bulbboard, although S had no difficulty reproducing other five-bulb linear patterns--for example, an edge pattern--or even certain alphabetic patterns--for example, E, H, T. In consequent investigations, Olson (1970, p. 8) addressed such questions as:

> When do children come to construct the diagonal? Why is the problem difficult? What do children know that permits them to construct the diagonal? How do they come to have that piece or form of knowledge? What is the relation between perception and a performatory act such as that of constructing the diagonal? What is the role of experience and instruction in this development? How is language related to this process of development? What is the nature of instruction?

OLSON'S ORIENTATION

Several years' work is reported in Cognitive Development. Olson tends to report the work chronologically in a detective-storylike manner, with new clues and orientations presented only after new evidence is in. Hence, some points in his orientation undergo change during the course of the exposition and so become concluding orientations based on evidence. Typically where an issue is large, Olson tends to enumerate his points, and to make a single choice from among fewer options than might be entertained. This tendency appears largely rhetorical; while it sometimes provokes the reader to offer counter-arguments, it does not appear usually to get in the way of Olson's doing things that need to be done. (Perhaps it is so that either-or rhetoric addressing large issues typically will prove irrelevant either to the search for evidence or to the level of theoretical account that such evidence implicates.)

THEORETICAL ORIENTATION

Primacy of theoretical schema. In line with his views on how perception develops, Olson believes that what one sees is the product of learned schema or representations; this is no different for those engaged in a scientific enterprise than for everyone else. A subplot of the book is Olson's struggle to overcome his own earlier biases and hence to "see" formerly-rejected evidence (whether before or after creating a new schema is not made clear).

Cultural effects. At a rhetorical level, Olson distinguishes rather absolutely between a naive objectivist view of nature as a single form that is perceivable or knowable and the view of cultural relativists and phenomenologists that nature can only be apprehended through the operation of experience-based perception. (Olson's logical positivism--or logical negativism as Pap called it--seems rather more in the spirit of the fifties than the seventies. However, while his prose may be either-or in this regard, he does not allow verbiage t stand in the way of engaging in a scientific enterprise.)

Measure of development. Most would agree that the developmental measure to which any or all skills will reference is an object of child development quests. Ultimately perhaps developmental age or level will be defined on ability to execute those performatory acts that the culture or subculture values. For present empirical purposes, studies of skill as a function of development must have some sort of factor stand in as the measure of development until a better measure is at hand. Olson chose chronological age. He sees fit from time to time to characterize a sample using socioeconomic class terminology, apparently to indicate that the sample is or is not restricted in a socioeconomic (subcultural?) sense. Olson's findings may be characterized as indicating how accurately a typical child at each of several chronological age levels will execute a specified performatory act under given circumstances. (Although commented on on occasion, rate or speed of the performatory act is not systematically studied.)

Intelligence as skill. Olson rejects the classical intelligence-testing enterprise on the basis of how its test items and tasks are selected. He views intelligence as culturally-defined skill--or as the sum of skilled executions of those performatory acts valued by the culture and referenced to the culturally-defined media. In his view, the proper role of investigators of intelligence is one of seeking to understand "how children become intelligent", rather than "how intelligent children are." Experience with the culture provides the basis for intelligent performance. (It is of at least diagnostic interest to the educator how "Olson-intelligent" children are on entry into given instruction. Here again the options seem too narrowly drawn.)

Task representativeness. Olson notes that those who investigate cognitive development employ a wide range of tasks and an appreciable age range of children. (One might add that such breadth is cumulative across investigators and programs and would be expected to bear upon Brunswik's (1956) notion of representative design primarily on the basis of accident or chance.) Olson's position is that, if chosen with care, then narrower task and perhaps age ranges will yield a better basis for discovering how children acquire cognitive skill. (If one curtails program breadth regarding factors that seem more peripheral to determining the form that cognitive learning takes--for example, a range of concepts or populations--then the resources saved can be diverted to related studies of factors that are apparently more central to such a determination. Representativeness is relative; any who would argue that Olson's tasks could be more representative still might agree that his programmatic orientation is superior to that of a broader literature reflecting few continuations, being more an arbitrary collection of fragments than a relatable representative data base.)

Perception and representation. Olson's terminal postulation is that "perception and representation are perceptual forms; they differ primarily in terms of what is perceived in the two cases [p. 14]." In Olson's view, the information contributed by perception is that which is common to the species. Such information arises in consequence of primitive perceptual cues--for example, edgedness, proximity, orientation--which in turn are tied to specialized receptor cell and network functions and precultural performatory acts--for example, locomotion, prehension. Representation of the perceptual world is a way of perceiving it that arises in consequence of culture-defined experience. (There is a sense in which the view is analogous to the out-of-style one that distinguishes between sensation and perception. But sensation has been banished. Hence, the remaining perception now must be partitioned into a more primitive component given to the species in consequence of receptor characteristics and the gross anatomy and a more adaptive, culturally-referenced component. This view traces back to the "new look" psychology of the late 1940s and early 1950s. Thought in Olson's formulations apparently is but a label for a theoretical account of developmental shifts in search strategies as the child moves beyond reliance on primitive to more special cues--a commendable view.)

Instructional system. Olson does not employ instructional system terminology but isolates some of the components of such a system. He notes that what pass for theories of learning lack an instructional component--or rather that such theories will not prove very exploitable until related to the classroom situation by theories of instruction. He distinguishes the performatory act and the medium that a performatory act references to. (He fails to distinguish between performatory act specification and criterion specification--or specification of the conditions that will be taken to reflect acceptable performance. Any sensible delimitation of the medium will make it true that the medium alone will not suffice to specify a performatory act; nor will specification both of medium and performatory act alone suffice to specify a criterion of act acceptability. In presenting media as vehicles of cultural influence or constraint, Olson appears, like McLuhan whom he cites, to be operating too near to the level of catchy but imprecise formulations.)

METHODOLOGICAL ORIENTATION

Empirical rigor. Olson's views on rigor cultism are consonant with those discussed by Lachenmeyer (1970). Olson rejects empirical rigor in the service of dull objectives or when rigor gets in the way of pursuing apt objectives. (This orientation is commendable. However, on occasion Olson veers toward making rejection of rigor functionally autonomous from the pursuit of empirical objectives; that is, he is sometimes "clinical" simply in the service of a predisposition toward sloth.)

Statistical inference. Anomalously it appears in light of his perspective regarding empirical rigor, Olson seems fully committed to that paradigm of statistical inference that requires one to adopt the view that the null hypothesis must never be accepted. That the cyclotron saved alchemy from having to accept the null hypothesis is cold comfort to any and certainly does not operate retroactively to make the lives the premodern alchemists rewarding to them or their society.

Criterion specification. Olson's study-to-study changes of performatory act and medium are restricted in number and modest in magnitude; such changes clearly follow from empirical intent. Such is not the case for changes in criterion performance--that performance that will be accepted as indicating skill in recognizing or constructing the diagonal. (The systematic study of multiple criteria is entirely legitimate. Olson's tendency to study multiple criteria systematically is minimal. Many different criteria are used; why is difficult to fathom excepting on a post facto basis.)

Form of instructions. Since children come to any study differentially experienced, Olson allows instructions to vary in consonance with the objective that comprehension of the task be made as comparable as possible across children. (This perceptive view deserves to be widely imitated.)

Anecdotal evidence. Olson is not above using anecdotal evidence when that is what is at hand. He appears consistently to label the practice when it occurs (which really is all that is required).

PERFORMATORY ACTS AND MEDIA

Excepting for eye-movement research--Olson's terminal study--the performatory act classified generally as a recognition or construction act; typically it was of the construction type. The typical construction act involved serial responding based on discretization of a pattern to be constructed. Typically the child was to copy from memory a five-checker linear pattern, beginning at one end of the pattern and proceeding linearly to the other end.

A rod-placement act having a unitary character was preliminarily studied in the context of a frame medium; a ruled-line act having a continuous character, in the context of a paper square medium. Four other media--including the major ones used in the research--were consonant with construction acts consisting of a series of checker placements to match a linear pattern. Three of these media were designed to get at and separate the Gestalt perceptual factors of edgedness, proximity, and orientation to the reference axis. (Perhaps it would be quibbling to call these "primitive cues" "fundamental concepts.") The fourth medium had a feedback capability consonant with "reinforcing" the individual responses of a serial performatory act. These media warrant brief description.

SQUARE BOARD

This checkerboard--which was Chinese checkerlike in that it provided spaced recesses into which checkers could be placed rather than adjoining squares--may be described as a five-rows-by-five-columns matrix or field. The square board was biased in favor of edge constructions on the basis of operation of the perceptual factor of edgedness. It was biased in favor of all row and column constructions on the basis of operation of the conceptual factor of proximity; on proximity grounds, it was biased against construction of diagonal patterns. That is, diagonal recesses were further apart than those for any other linear pattern using five checkers. It was biased in favor of row constructions on the basis of operation of the conceptual factor of orientation (or parallelity to the reference axis).

Such a medium consists of two components: the checkerboard and the set of checkers provided for placement on the board. One may define the performatory act generally on from one to 25 checkers and the act testing for construction of a linear pattern on from two to five checkers. Problem difficulty varies with number of checkers in the pattern. Given the five-by-five checkerboard, the five-checker pattern defines a more stringent chance probability that S will construct a given pattern in an acceptable sequence than does a four-checker pattern. Also of interest, provision of a ruler and chalk well might lead to other performatory acts referencing to the checkerboard, as might provision of a knife or hatchet. If the medium is to have any constraining effect whatsoever upon the performatory act, then the "response elements" provided will need be viewed as a separable component of the medium. (Act specification, of course, supplies the fine details concerning how response elements will be brought to the board.)

DIAGONAL BOARD

This checkerboard was similar to the square board except that its 25 recesses were differently distributed. A given diagonal pattern featured seven equally spaced recesses. Whether viewed in the horizontal or vertical plane, the successive edge-to-edge linear patterns of the board contained 4, 3, 4, 3, 4, 3, and 4 recesses respectively. There was an edgedness bias in favor of edge patterns, an orientation bias in favor of row patterns, and a proximity bias in favor of diagonal patterns. That is, recesses of a diagonal pattern were closer together than those of any other linear pattern involving placement of five checkers.

Olson presents a figure showing seven checkers placed in the diagonal of the diagonal board. On this board no more than four checkers could be used to form a row or column pattern. Thus, it is necessary when the diagonal board is used either to provide seven checkers, even though the act might require that fewer be placed, or to cue S concerning the class of pattern to be constructed by providing either three to four or seven checkers.

ROUND BOARD

This checkerboard differed from the others in that it featured one horizontal, one vertical, and two dissecting oblique patterns. Each pattern consisted of five equally spaced recesses, all patterns shared a central (third) recess, and all had their first and fifth recesses falling on one imaginary circle and their second and fourth recesses on another. Whereas the square and diagonal boards contained 25 recesses, the round board contained only 20. If S was able to project a suitable reference axis, then the round board showed an orientation bias in favor of the horizontal pattern. Regarding edgedness and proximity cues, the round board was unbiased with regard to any pattern.

BULBBOARD

Olson describes the bulbboard, whose invention is attributed to Bruner, in detail in an earlier publication. The bulbboard's configuration is analogous to that of the square board except that bulbs replace recesses. The bulbboard could be programmed so that any bulbpress that corresponded to a "response element" of a pattern of interest would cause the bulb to light up, thus providing a form of feedback. (The bulbboard is superior to the squareboard as a feedback device only under certain conditions--for example, that where a correct response stays marked over the life of the performatory act. Marking that occurs only for the life of the response can be simulated on the square board simply by having E indicate that a square board response is right at the time made. The advantage of the bulbboard in this case is that it provides for automatic recording of the individual responses. Another potential of the bulbboard is to provide positive feedback only when the individual response or bulbpress occurs in criterion-defined proper sequence. Olson did not exploit this capability in the research reported.)

PREREQUISITE SKILLS AND PERFORMATORY ACTS

Pattern construction was guided by a model of the pattern and a record of prior responses made during the construction attempt. However, when S performed on the square, diagonal, or round board, the pattern model was absent and the record of prior checker placements present on the board. When S performed on the bulbboard, the pattern model was present and the record of prior responses absent. The checkerboard media required S to carry in memory his representation of the pattern; the bulbboard, to carry a representation of his own prior responses (or those marked correct) in memory. Both sorts of media entail memory skills; it is possible that performatory acts referencing to the two classes of media entail different degrees of memory skill as prerequisites to act acquisition.

Excluding Olson's eye-movement research, skills were partitioned into prerequisite and performatory act components in one of two ways. In the broad spectrum case, S was allowed to participate in the study if he demonstrated an understanding for the multiple-response performatory act short of making any other such response than one involving a top-row pattern. In the narrow spectrum case--where diagonality was studied more intensively--the child was allowed to participate only if, in addition, he demonstrated skill in constructing all patterns featuring the primitive perceptual cues (edge and interior row and column patterns) and lack of skill in constructing the diagonal.

In the broad spectrum case, Olson studied S's ability to construct a range of patterns--for example, top edge, right edge, middle row, second column from right, left-oriented diagonal, right-oriented diagonal. In the narrow spectrum case, no pattern below the diagonal level of complexity was presented during criterion skills evaluation. Where intramedium transfer was evaluated, an opposite diagonal pattern served as the transfer task. Intermedium generalization was only preliminarily studied.

SOME OTHER FACTORS

CULTURES AND SUBJECTS

Paramount consideration was given to children of the "culture" of the eastern United States and eastern Canada--children of a postindustrial culture--who distributed for the most part across the middle socioeconomic class of the culture. A second culture studied less intensively was an African tribal, or preindustrial, culture, as reflected by the children of two somewhat similar tribes in Kenya.

Children of the postindustrial culture typically were obtained from nursery schools if less than school age or from public or private elementary schools if of school age. More usually than not, the children enrolled at one or two nursery schools all would serve as subjects, regardless of how they might distribute across the chronological age dimension. Hence, findings related to this dimension typically are based on unequal Ns, a condition that also prevails for findings referencing to the preindustrial culture.

CRITERION PERFORMANCE

No generalizing statements come to mind concerning criterion performance, since this varied a good deal across the body of research that Olson reports. Criterion specifications will be noted as appropriate under study summaries.

INSTRUCTIONAL TREATMENTS

Instructions specifying the performatory act themselves constitute instructional treatments. In that sense, all studies reported by Olson manifest instructional treatments. In a more conventional sense, only certain of the studies featured instructional treatments designed to shed light on characteristics of instructional intervention that might prove useful in teaching the diagonality concept. These will be noted as appropriate under study summaries.

PROGRAM OVERVIEW

The research reported by Olson is presented in Chapters 3 through 8 of the book. Chapter 3 research (Experiments A, B) establishes that for younger Ss there is an order of difficulty for construction of the different patterns and that this order is related to presence or absence of the primitive perceptual cues, of which proximity appears the most critical. Chapter 4 (Experiment C) attempts to evaluate the gross question whether associative or cognitive instruction is most effective in teaching the child to construct a diagonal. However, it succeeds only in evaluating whether it is better to point out to the child some of the attributes and relations between attributes of the diagonal or simply to mark as correct the individual responses of the pattern without respect to order as the instructional treatment. From a standpoint of what he succeeded in evaluating, many would think it trivial.

Chapter 5 (Experiments D, E, F) preliminarily evaluates whether failure is due simply to perceptual factors and, finding this untenable, gathers clues to the sorts of instructional treatments that might improve diagonal construction. Finally, it is preliminarily established that the same children who fail to construct the diagonal when it is presented as a sequential construction requirement succeed when a nonsequential performatory act (rod placement) is required. Chapter 6 (Experiments G, H, I) explores more fully the sorts of instructional intervention that might improve construction of the sequential diagonal--for example, verbal-conceptual, motor-conceptual.

Chapter 7 (Experiment J) more or less repeats the square board-referenced portion of Experiment A using Kenyan children and multiple regression analysis to suggest factors underlying diagonal performance. This study was accomplished and earlier reported by Robert and Ruth Munroe, an anthropologist and child psychologist respectively. Chapter 8 (Experiment K) relates eye-movement records to (other) performance records.

STUDY SUMMARIES

Study A (Pattern-Referenced Act Difficulty I)

1. Subjects. N = 29, aged 3-5, presumed of "above average ability."

2. Media and performatory acts. Media used were square, diagonal, and round boards, with appropriate checkers. Performatory acts studied for square and diagonal boards were, following removal of a pattern modelled on E's board, to construct top and right edge patterns, middle and second from right row patterns, and left- and right-oriented diagonal patterns. For each of these boards, then, S was required to construct two edge patterns, two interior row patterns, and two diagonal patterns. Acts studied for the round board were to construct one horizontal, one vertical, and one unspecified oblique pattern. The horizontal pattern is analogous to that for an interior row; the oblique, to that for a diagonal. The vertical pattern of the round board has no analogue in square and diagonal board patterns studied.

3. Warmup. During warmup, the child was evaluated for the prerequisite skills of a wide spectrum study and then acquainted with the sequential construction task using the top edge pattern as an exemplar of the task. During this phase, E placed his board over S's and showed the pattern to be constructed. S then was required to trace over the pattern with his finger, a procedure widely used in Olson's program. E then withdrew his board and S constructed the pattern from memory. During warmup trials referencing to the top edge pattern, errors were corrected. S apparently came to the main study able to copy the top edge pattern on the square board.

4. Design. The design description provided by Olson yields more information than is presented here but not all that one might ask for. S attempted to construct the 12 square and diagonal board patterns on Day 1 and the three round board patterns on Day 3 or 4. Apparently, an assumed order of difficulty was defined exclusive of board characteristics and this order was applied during Day 1 testing, with the easiest pair of square-diagonal board patterns being presented first and the hardest pair last. Two such cycles occurred. Olson notes that failure on an easier pattern during the first cycle, with a more difficult pattern being successfully negotiated either on that cycle or the later one, could either be attributed to practice effects or to a defect in the assumed order of difficulty. When this occurred, he sought to diagnose why following completion of the second cycle.

5. Criterion. Two scoring criteria were employed, one for all boards and the other for square and diagonal boards. The first criterion was two-category (right, wrong). First-criterion findings reflect the percentage of all attempts to perform the act that were correct (rather than of all Ss who succeeded). The second criterion was three-category (right, configuration correct but displaced, wrong). (A comment made in the report of Experiment B reveals that scoring was 2, 1, 0.) The second criterion was used for purposes of predicting S's success based on his prior success (Olson's Table 3-1).

6. Results. Data based on the first criterion are presented in Olson's Figure 3-3. Quantification of the bar graph information presented in the figure yields the percentages of correct constructions, by type of board and class of pattern shown in Table 1.

Table 1

Study A Percentages of Correct Responses (Two-Category Scoring)

Board	Edge	Int. Row	Diagonal
Square	63	38	16
Diagonal	74	15	25
Round		70	56

Note: Discrepancies among Olson's Figure 3-3, from which these data are extracted, the accompanying text, and his later comments made during the description of Experiment B, lead to the suspicion that the Figure 3-3 data are not those he intended to present. Rather, he appears to have intended to present data based on the three-category scoring system.

Based on the Experiment A data--whether for the two-category or the three-category scoring scheme or both is not clear--Olson constructs a hierarchy of pattern (or act) difficulty (Figure 3-4, page 34). The hierarchy may be summarized as follows:

a. The most difficult pattern is the diagonal on the square board, for which none of the primitive perceptual cues can be used as an aid to construction.

b. The next most difficult pattern is an interior row pattern on the diagonal board, for which only the cue of parallelity to the reference axis can be used as an aid to construction.

c. The next most difficult patterns are the interior row patterns for the square board and the diagonal pattern for the diagonal board. In both instances, the cue of proximity can be used as an aid to construction.

d. The easiest patterns are the edge patterns for the square board and the diagonal board. In both instances, the cue of edgedness can be used as an aid to construction. (Parallelity does not apply to the right edge pattern; proximity does not apply to edge patterns for the diagonal board.)

7. Discussion. Olson provides (p. 35) the following summary view. "First, when everything else is constant, as the comparison of the Diagonal on the Square Board with that on the Diagonal Board, the nonproximate is substantially more difficult. Second, when proximity is held constant, as on the Round Board, all problems are relatively easy. Third, it is the figure-ground factor [based on proximity] that is overcome at about Kindergarten age . . . [making it possible to solve such problems as that involving the Square Board diagonal pattern]."

8. Commentary. Agreeing that the Gestalt perceptual cues are less exploitable on the round board than on the others, why is performance on the round board so good both for orthogonally and obliquely oriented patterns? Is it because younger children overuse only partially appropriate information when present but get along without it when withheld? Following eye-movement studies reported in Chapter 8, Olson concludes that older children perform better on pattern construction because earlier experience teaches them what to look for during the perceptual phase of training-testing. This does not entirely jibe with round board findings for Experiment A, where one can infer that "children knew what to look for" in consequence of their doing so well on every construction task evaluated.

One possibility is that the round board of Experiment A offers erroneous choices that are easier to evaluate as erroneous than are the erroneous choices for Chapter 8's diagonal patterns, which reference to a five-by-five grid that is analogous to the square board. Imagine a round board having a 3-inch radius measured from the center of its center hole to the center of any hole on its outermost ring. Imagine a square board that is similarly constructed so that the distance across from the center of a hole on one edge to the center of a hole on the opposite edge is 6 inches. Assume errors adjacent to the diagonal or oblique as "the only feasible ones." Assume that holes are 1 inch in diameter. Such hole diameters conform to scale (Olson's Figure 3-2). For the round board, then, edge-to-edge proximity of adjacent errors progressively across the oblique is the set of inch values 84/64, 37/64, 37/64, 37/64, 84/64. The mean distance of an adjacent error then is 7/8 of an inch. For the square board, every possible adjacent error has an edge-to-edge proximity of 1/2 inch. Not only does the average possible adjacent error for the round board oblique exceed every possible adjacent error for the square board in terms of proximity, but every possible round board adjacent error exceeds every possible adjacent error for the square board in terms of proximity.

What we have done is to use proximity in a quantitative sense in support of the view that adjacent errors on the round board are easier to evaluate as errors (or to discriminate) than on the square board. While the Chapter 8 findings may be consonant with the view that older children know what to look for in light of earlier experience, the present round board findings suggest that one cannot adequately evaluate a view that experience teaches children what to look for without taking into consideration the extent to which alternative erroneous responses fall away from the pattern. There is a tradeoff between increasing experience and increasing departure of alternative erroneous responses from pattern. Perhaps younger children can make do with less experience if alternative responses compensate by representing greater departures from pattern. Perhaps this is to say that, when dealing with such factors as the Gestalt perceptual cues, we need to consider not just the relational topology or geometry of the situation but also the quantitative manifestations of these relations.

Study B (Pattern-Referenced Act Difficulty II)

1. Subjects. N = 68, aged 2-5.

2. Media and performatory acts. Media used were square and diagonal boards, with appropriate checkers. Six patterns--three for the square board, three for the diagonal board--were used. Square board patterns to be constructed were right edge, second row from top, and right-oriented diagonal. Diagonal board patterns were left edge, second row from bottom, and right-oriented diagonal.

3. Warmup and design. Warmup apparently followed that for Experiment A. Design featured a randomized order of pattern presentation. For each pattern, S received two trials (apparently in succession). At the end of every trial, S received a candy "reinforcer" without regard to outcome.

4. Criterion. The same criterion scoring procedures were used as are described for Experiment A. It appears that the two-category scoring procedure was taken into the study and the three-category procedure introduced during analysis to account for certain discrepant findings. (Use of the three-category procedure for this purpose during Experiment B is the prime basis for the suspicion cited earlier that the data presented in Figure 3-3 for Experiment A are the wrong data, based on the wrong measure. Other detective work suggests, however, that the Figure 3-3 data at least approximate in magnitude the data that use of the three-category measure would provide.)

   For reasons that are not made clear, Experiment B relaxes the criterion of success referencing to the two trials administered per pattern. Performance is considered entirely correct if entirely correct on at least (or no more than) one of the trials (and presumably partially correct under similar conditions).

5. Results. The data are presented in bar graph form in Figure 3-5. Quantification of data based on three-category scoring yields the percentages of Ss (not of attempts, as earlier) getting at least one of two attempts correct or partially correct, by type of board and class of problem. These data are presented in Table 2. Beyond pointing to differences in procedure and scoring from Experiment A to Experiment B, there is little point in speculating why tabled values for Experiment B should be so much higher than those for Experiment A.

Table 2

Study B Percentages of Ss Responding Correctly or Partially Correctly in At Least One of Two Trials (Three-Category Scoring)

Board	Edge	Int. Row	Diagonal
Square	90	77	56
Diagonal	80	65	73

6. Discussion. Olson states that Experiment B findings support the view that Gestalt cueing factors, when absent, account for failures to construct diagonals. (These failures are less profound relative to failures for edge and internal row patterns under conditions of Experiment B than of Experiment A.) He goes on to note that the question is not what, absent, accounts for

failure, but what, present, leads to success. Many children do not fail. How is it that they get along without the "field-dependent" information provided by proximal cues to reach a "more field-independent" mode of operating?

Olson's view of the contribution of Experiments A and B to program objectives references to a schematic (Figure 3-6) representing or hypothesizing the differential effects of perceptual organization and conceptual systems over development with age. The schematic shows "structure provided by perceptual organization" to predominate during earlier development and "structure provided by conceptual systems" to play the greater role later in development. (The figure is reminiscent of those used to portray the shift over instructional time of reading programs from an initial concern almost exclusively with identification skills to a later primary emphasis on comprehension skills [c.f., Desberg & Berdiansky, 1968, Fig. 1, p. 2]. Such representations tend to be more believable than helpful). Olson notes that the first two studies address only the perceptual component of his schematic. Later he will argue that perception and conception (or representation) are only different facets of perceiving.

Study C (Effects of Instruction I)

As noted earlier, either Study C is flawed in terms of what it seeks to accomplish or what it seeks to accomplish is trivial.

1. Problem. Olson addresses two questions in Study C (p. 43): 1)"Can one draw any inferences about the nature of [the concept of the diagonal] from a description of the instructional procedures most effective in teaching it?" and 2) "Can one evaluate the [relative] utility of association [and] cognitive theories in predicting [effective learning of diagonality? Measures] of effectiveness [are] taken as a) efficiency of learning (time and trials to criterion), b) transfer to a new task, and c) recall after three weeks."

2. Background. Problem background is indicated by the following quotations or descriptions based on Olson's wording.

   a. Relation of learning theories to instruction. "Learning theories have never contributed simply or directly to instructional theories . . . Nevertheless, these theories are suggestive of what should be done in order to get the child to learn a complex act. [Experiment C derives instructional treatment] from two major types of theories, an associationist reinforcement position, and a cognitive structure position [p. 42]."

b. Associationist view. "The associationist view [e.g., of Thorndike, Skinner, and Staats] holds that the critical features of learning are contiguity, pairing S and R or a series of Rs, and following the desired response by a reinforcement . . . If the diagonal is construed as a response composed of a set of responses, and if learning takes place primarily through the occurrence and reinforcement of these responses, it follows that the diagonal will be learned through the reinforced practice of these responses."--(pp. 42-43)

The foregoing statement is an innocuous one. It becomes clear only later when Olson reveals how he interprets the associationist view that he seeks to test a Thorndikian or pre-Thorndikian view of association. At the risk of getting ahead of our story, we examine the treatment of a "trial-and-error" group of Experiment C in relation to required performance.

The requirement is to learn an ordered sequence--either of 2 of 120 possible sequences--of five individual responses constituting a diagonal pattern. For the trial-and-error group, Olson reinforces or provides feedback for each correct individual response made on a bulbboard <u>without respect to order</u>. That is, every time that <u>S</u> presses a bulb that is part of the pattern, the bulb lights, then extinguishing when pressure is removed. In effect, the feedback provided asserts that the sequential facet of the task is inoperant. <u>S</u> can only overcome this misinformation by discovering that his performance is unacceptable after repeated attempts to copy the pattern. This he does presumably by suitably interpreting <u>E</u>'s encouragement that he stay with the task (until successful).

One of the earliest of the reinforcement theorists to distinguish systematically between unitary responses and response chains was Hull (1952). While Skinnerians have devoted their greatest efforts to responses that are viewed as unitary, even they--Ferster & Skinner (1957), Verhave (1966), for example--acknowledge that chained responses are a different phenomenon than unitary responses. However one evaluates Skinner's (1957) views on language acquisition, it is evident that he views utterances as <u>sequential constructions</u> whose temporal sequential character is acquired because the model to which the child is exposed has this character.

The visually-represented diagonal pattern does not signal a sequential character. While it may fit any individual's own parochial view of diagonality defined on sequential construction that the concept to which the construction act references has a spatial sequential character, it does not seem compelling that the model presented should convey this. If feedback misinforms S in this regard--by asserting absence of a sequential requirement--then even the purest of current associationists would have to consider such a training treatment ex cathedra inefficient (if not ineffective).

c. Cognitivist view. "The cognitive [view, e.g., of Piaget, Bruner, and Ausubel] emphasizes the 'structure' or the relationship that the child imposes upon any set of relevant components. Given any set of input information, the child constructs a model that most coherently and economically 'represents' or accounts for that input . . . instruction in this case would emphasize the 'relatedness' or structuring or patterning of the elements such that the child would come to see the relation of the component parts to the whole [p. 43]."

d. Mandler's view. Finally, Olson cites Mandler's view that pattern may materialize in consequence of overlearning of associatively-learned nonpatterned subresponses--that is, that associatively-learned unpatterned response components of the patterned response are propaedeutic to forming a pattern generalization.

It appears possible that Olson's interpretation of association doctrine for purposes of Experiment C arises from his exposure to Mandler's view. We interpret Mandler's view as a hypothesis (some data in support of which he obtained using adult Ss) that patterns could perhaps be formed by overlearning associatively-learned nonpatterned subresponses. If instructional time and effort are immaterial, then of course many such possibilities arise. As Olson understands, the quarry is an efficient instructional treatment, not just one that might prove effective if S can be kept alive and working indefinitely. Mandler's view bridges the associationist and cognitivist views that Olson acts upon. However, those near the educational action would have to consider it a bridge between nothing and maybe something.

3. Subjects. N = 118, aged 3-6, presumed representative of the general-category educational (or preeducational) population. From this sample were selected 28 Ss able to copy top and bottom row and left and middle column patterns but not a left-oriented diagonal pattern. A full account of this study is presented elsewhere (Byrne, J.M. Acquisition of the Concept of Diagonality in Young Children. Unpublished M.A. thesis, Dalhousie University, Halifax, Nova Scotia, 1966).

The 28 Ss used in Experiment C were identified on the basis of a screening study involving the original sample of 118 Ss. Of passing interest are the percentages of Ss rejected because they were able, without training, to copy all patterns, including the diagonal. These data, reconstructed from the data presented in Olson's Table 4-1, are presented in Table 3.

Table 3

Study C Ss Able to Copy the Diagonal without Training

Age	Number	Number Correct	Percentage Correct
3	14	4	29
4	53	20	38
5	36	28	78
6	15	15	100

These and similar data presented by Olson reflect a function having sigmoidal form. However, such functions differ in certain details. Thus, Experiment C children aged 3 do more poorly than children aged 3 of Chapter 6 studies, while Experiment C children aged 5 do better than children aged 5 of Chapter 6 studies. Experiment C uses the bulbboard; Chapter 6, the square board. Whether the square board is easier for younger children and the bulbboard easier for older children or the samples are from different populations cannot be evaluated on the basis of the data available.

4. Media and performatory acts. The bulbboard medium was used. The performatory act of acquisition was to copy a left-oriented diagonal on the bulbboard from a model of the pattern placed above the board. (Transfer was evaluated using the right-oriented diagonal pattern; retention was evaluated three weeks later.)

5. Instructional Treatments.

   a. Group 1 (trial-and-error group). N = 14. S was required to study the model (or note it carefully), to point to the individual "bulbs" of the model of the pattern, and then to press bulbs on the bulbboard until he could press all those that lighted and none of those that did not. From time to time S was encouraged to reexamine the model. He was asked to stay with the task until he solved it (that is, for an average of 51 minutes, whether with or without rest pauses is not made clear).

   b. Group 2 (structured learning group). N = 14. Here, "the concept of the diagonal was related to other relevant concepts, such as corner, straight line, and middle [p. 45]." The objective was to get S to "formulate a general verbal rule of the form, 'The crisscross starts at a corner, and goes straight across the middle to the other corner' [p. 45]." Following formation of such a rule, S was tested on the bulbboard.

6. Criterion. There was, for both groups, an acquisition phase that terminated when S negotiated five errorless trials on the bulbboard. A trial was defined as a five-press run and a correct trial as one that formed the left-oriented diagonal in end-to-end sequence. Whether it was required that errorless trials be consecutive is not stated. Following criterion performance (presumably with little delay), S was tested for transfer using the right-oriented diagonal pattern.

   For reasons that can only be inferred (below), the transfer criterion was three errorless trials (as opposed to the acquisition criterion of five). Approximately 3 weeks after original learning, S was retested first for construction of the left-oriented diagonal and then for construction of the right-oriented (transfer) diagonal. Retention criteria apparently were those used to evaluate original learning and transfer.

   Not all Ss achieved transfer criterion performance (a likely reason why the transfer criterion requires fewer errorless trials). Hence it was necessary to define secondary measures.

   a. Twenty-response measure. Groups were compared for errors made during the first 20 training, transfer, and retention trials. (Olson's use of trial here apparently means an individual response, a fifth of the five-press run.)

b. Five-response measure. A secondary analysis was performed using a success criterion of four correct responses during the first five presses on transfer and retention tests.

7. Results.

a. Characteristics of groups. The data presented in Table 4 were obtained from Olson's Table 4-2. All of the Group 1 training time (exclusive of a small amount of time spent looking at the model) was bulbpressing time. All but part of a minute of the Group 2 training time was rule-learning time. Hence, as Olson notes, training time is the more meaningful measure for the acquisition phase. Not all children reached transfer criterion performance. Those who did not in approximately 1 minute were terminated.

Table 4

Study C Group Characteristics

Factor	Group 1 Mean	Group 2 Mean	t
Age	54 mos	55 mos	
Training-Retention Delay	26 days	27 days	
Training Time, Left Diagonal	51 min	24 min	4.59*
Training Trials, Left Diagonal	470	34	4.10*
Trials to Transfer to Right Diagonal	55	24	3.46*

* $p < .01$

b. Training, transfer, and retention errors. If transfer evaluation was not completed through criterion attainment after "50 to 60" trials (responses), it was terminated. Errors during the first 20 training, transfer, and retention responses, indicated in Olson's Table 4-3, are shown in Table 5.

Table 5

Study C Mean Errors during the First 20 Training, Transfer, and Retention Responses

Phase	Group 1	Group 2	t
Acquisition (A)	13.6	3.1	9.93*
Transfer (T)	14.1	6.0	4.76*
Retention of A	4.9	3.4	
Retention of T	11.6	2.9	4.08*

* $p < .01$

c. Secondary analysis. The number of Ss attaining four correct presses in their first five presses during transfer and retention testing, indicated in Olson's Table 4-4, is shown in Table 6. Olson notes that Group 1 did better on transfer retention than on original retention--to be discussed.

Table 6

Study C Ss Four of Whose First Five Responses During Transfer and Retention were Correct

Phase	Group 1	Group 2	X^2
Transfer (T)	0	12	17.6*
Retention of Acquisition	11	13	1.33
Retention of T	5	12	7.34*

* $p < .01$

d. Analysis of individual protocols. Olson reports that some Group 1 Ss, at intermediate points in training, have eliminated commission errors but simply are failing to press one or two bulbs of the sequence. He fails to comment on the fact that such children are for the most part reacting sequentially at intermediate points in instruction, although the feedback schedule misinforms them on this point. Olson describes a Group 1 child (Barbara S.) whose approach proves that a Group 1 S can discover the pattern without the model. This S systematically pressed bulbs row-by-row, left-to-right and top-down to determine what bulbs light up. Her performance supports the view--presumably shared by some advocates of unsupervised education in the streets--that trial-and-error learning, however inapt, can be both effective and inefficient. (It appears that the Group 1 protocols have implications that Olson did not discover.)

8. Conclusions. Olson concludes (p. 53) that "a cognitive theory that emphasizes the relation between the whole and its parts, or between a concept and its attributes, is much more in line with the evidence found in this study [than an associative theory]."

9. Commentary.

   a. Feedback. Inaptness of Olson's feedback procedure is previously commented on. Later comments by Olson, particularly in consequence of an instructor's demonstration of a Montesorri approach to training a young child to construct the diagonal, indicate that Olson is positively predisposed toward feedback. Whether current reinforcement theory has any contribution to make to concept learning is not touched by Experiment C. The experiment is content to tell us that a form of feedback that most would consider inapt truly is that.

   b. Group 1 improved-transfer with delay. If the Group 1 child came to the original transfer task tired--and we are not told enough about conditions of work during original acquisition to evaluate the matter--then original transfer performance might not have represented his best effort. If that were so, then the intervening weeks might dissipate all that reactive inhibition, freeing the child (or some children) to show better transfer performance during the retention phase, even though forgetting effects might be operating.

   c. Mandler's view. Olson argues (p. 53) that the data offer little support for Mandler's view "that structure arises from the overlearning of simple associations." Perhaps this is so. However, in most studies involving successive trials to criterion performance, there really are two sources of feedback--one concerning correctness of the individual responses and one concerning acceptability of the overall performance. Even if E wishes to do so, he finds it difficult to conceal from S for long that more is required than that the correct individual responses be made without respect to order. It is possible that a closer look at Mandler's work and his view would find these predicated on two such sources of feedback. Since the Group 1 protocols offered by Olson reveal that sequentiality--in the sense of going from end to end, although with omissions--has in general been learned, the data may not be so far from supporting a view like Mandler's as Olson believes. (In Chapter 8, based on eye-movement data, Olson concludes that such omissions as Group 1 protocols reveal result from younger Ss operating in the recognition mode--they do not search the pattern well enough to insure its construction but only well enough to differentiate it from some other pattern. If that is so, then the most damning thing that can be said about Olson's trial-and-error treatment is that it does not specify the performatory act as well as it should.)

d. Summary. Olson believes that the diagonal concepts should not be construed as a response or a series of independent responses. (Nor, perhaps, should it be viewed as media-defined in any narrow sense. While the concept of diagonality transcends that of an exemplar response sequence, in Olson's tasks it tends to reduce to one or two exemplars requiring sequential construction. The concept is more abstract than Olson's use of it would indicate. Olson finds that even a little rule-based instruction helps; this is gratifying. His view (p. 55) that the study reveals that "conceptual learning is of a massively more generalized nature than learning a response" is proven only in a trivial sense.)

Study D (Perception and Performance)

1. Problem. Olson's Chapter 4 yields the following summary of alternative views concerning what information S requires to construct the diagonal.

   a. Reinforced responses. H: What must be learned is "a series of responses that are stamped in by differential reinforcement." In Olson's view, this hypothesis is not very tenable.

   b. Perception. H: What must be learned is an experientially-based perceptual schema (a view of Bruner, of E. Gibson, and of Maccoby & Bee).

c. Performance. H: What must be learned is complex motor skills involved in reconstruction.

d. Conceptualization. H: What must be learned is "a system or schema for thinking about or representing the diagonal as a basis for . . . reconstruction." Olson favors this view.

Study D addresses the middle two of these alternatives. The Chapter 5 prologue appropriately characterizes answers provided by Study D (and Studies E and F) as preliminary "based primarily on anecdotal evidence." Olson notes that he will later argue that the rubrics of perception, performance, and conceptualization may necessitate revision.

2. Perception.

a. Subjects. N = 10. Ss were nursery school children of unspecified age, able to copy row and column patterns but unable to copy a diagonal pattern.

b. Procedure. The diagonal pattern was presented on E's board, S traced over it with his finger, and the pattern was withdrawn from view. S then incorrectly constructed the diagonal on his (square) board. Then he was shown both patterns--model and construction--side by side (presumably randomly ordered) and required to judge which was the model pattern. Procedure was repeated across trials.

c. Results. "In view of the long delay after the child viewed the . . . model the results are surprising. Eight of the ten Ss immediately and consistently pointed to the model that they had been shown [p. 57]." Olson notes that Ss might have done less well if their own constructions had been quite similar to the model construction. (A discrimination study procedure that systematically varies degree of departure from the model might have provided both more and more definitive information.)

d. Discussion. A preliminary conclusion is that faulty construction is not due to faulty perception.

e. Commentary. There are really two unknowns in the equation Olson is trying to solve with a one-factor study. How may we characterize the perceptual system? Ontogenetically, how may we characterize the conceptual system? At this stage, Olson can only evaluate perceptual performance on the basis of an intuitive view of a conceptual system whose ontogeny apparently is perspicuous to no one.

(1) Olson adopts (p. 59) the "convention of using the term 'distinguishing feature' to refer to those cues that are presumably involved in perceptual recognition, and using the term 'attribute' to refer to those cues that are involved in a conceptual system such as ordinary language or mathematics." The spirit of the distinction is commendable; however, it remains to determine what, operationally, will be taken as distinguishing features. Are these inherent in the perceptual world, subject to the different reaction tendencies of the specialized sensory cells of the species--for example, of the retina of man? If so, then the study has little to do with evaluation of perception. If not, then what are the "distinguishing features" whose perception the study proposes to evaluate. Based on Olson's eye-movement research and Study C findings referencing to individual protocols for Group 1, one speculates that these features either are a) the ends of the diagonal pattern or b) the middle of the diagonal pattern. But features so characterized are uncomfortably near to the status of attributes of the concept, with some relational characteristics thrown in.

(2) With others Olson notes that recognition of a form appears to involve simultaneous processing of whatever information is used to effect recognition, whereas production of a form necessarily is sequential over time in that not all facets of the representation can be produced simultaneously. Let us mean be simultaneous only that little time is involved either in scanning input or responding and that the response we are able to monitor under these conditions appears to have a one-step character. When we reach such a reasonable view of simultaneity, we find ourselves returning to Olson's observation that discrimination might not have been so good if model and comparison pattern had been more similar. Recognition of a pattern, or labelling it as a member of a class, depends on what the alternative classes are, as Olson notes. Simultaneous processing notions may be only a screen to hide the fact that we have not yet gotten around to quantifying how much information must be picked up to perform a given act. As matters stand, the only "operational" sense that we can give to Olson's perception-dependent performance may be stated negatively as that which is not grossly--at a molar level--sequential over response components. This line of argument suggests, in line with a view that Olson will come to, that "perception" and "representation" label

opposite poles of cognition. Recognition acts involving a "more unitary" use of the eyes fall at the perceptual end of cognition. Construction acts involving "more sequential" use of the eyes and sequential performance using a hand fall more toward the representational end of cognition.

3. Performance. Olson argues, somewhat convincingly in light of his own findings, that what stands in the way of diagonal construction is not absence of motor skills. In his view, the perception study tends to rule out faulty perception; logical analysis and sundry items of experimental and anecdotal evidence rule out faulty motor skill. Findings of Experiment C (and more apt ex cathedra arguments) tend to rule out response learning when the concept to be learned is diagonality, the medium defines transfer tasks, and multimedia define a generalization domain. What remains is faulty conceptualization.

Study E (Conceptualization)

1. Problem. How does a child transition from prediagonal to diagonal conceptualization (and skill)? Olson hypothesizes (pp. 61-62) that:

    a. The prediagonal child perceives the pattern as a whole and any part of the diagonal in isolation but not the whole as a set of related parts.

    b. The child transitions to diagonal construction in consequence of his inventing or receiving instruction on a conceptual organization or structure that relates parts to whole for the diagonal. He goes on to say that this system "is not given, or even inherent in the stimulus array or in the perceptual recognition."

    c. Commentary. The substance of the view that a conceptual structure is culturally given rather than inherent in the stimulus array or species-defined perceptual functions is that how nature influences conceptual schema is left unspecified. We assume that a culture defines a conventional conceptual structure because in some sense such a view proves useful to that culture. If that were not so, then Olson's position would reduce to an ultimate phenomenology wherein each individual or each culture was privileged to reach a uniquely arbitrary view of nature. It is an easy enough matter to agree that culture contributes or invents such notions as square and diagonal. However, once the notion of square is invented, it seems that one is thereafter constrained concerning the concepts that one will define on that concept. Given a square in plane space, one is privileged to define such related factors as side, angle-corner, perimeter, area, diagonal, and quincunx. It is not necessary that all cultures sharing the notion of a square in plane space share a view on the set of related characteristics, but it does appear unreasonable that such characteristics or attributes as circumference, diameter, radius, and quintile be used to characterize the square as such. What Olson must intend to say regarding stimulus characteristics is that, while not irrelevant to forming a conceptual structure, they are insufficient. Naive objectivism distorts our view of man's habitat by repressing personal equations. It is not necessary, even at the level of rhetoric, to counterattack with naive subjectivism, whose implication is that neither nature nor human wiring constrain the choice of conceptual blueprints.

2. Procedure. Study E is not a learning experiment in the usual sense. Although somewhat interventionist, it is somewhat anthropological in that it hunts for hints to conceptual structure among children of the prediagonal and transition cultures. Ss were 59 nursery school children, some of whom were transitional regarding ability to construct diagonals. A checkerboard study procedure was used except that the object was to find out what conceptual structure S was using. The following procedural variations are reported.

   a. "Correcting nondiagonal patterns." E constructed different diagonal and near-diagonal patterns and asked S whether each was a diagonal, why, and, if not, what would need be done to make the pattern a diagonal.

   b. "Correcting nondiagonal pictures." Procedure paralleled that for correcting nondiagonal patterns except that E presented a pattern constructed on a card from small pictures--for example, of a duck--to form a diagonal or non-diagonal exemplar.

   c. "Completion of diagonal patterns." S was asked to complete a diagonal pattern constructed by E with one or two checkers omitted.

   d. "Knowledge of parts of the diagonal." E placed a corner checker in his board; S copied on his board; these checkers were removed. E placed a checker in the next adjacent diagonal recess, S copied on his board. This continued until the last checker was copied at the opposite corner.

e. "Perceptual markers for the diagonal." E marked opposite ends of his diagonal construction with checkers of contrasting color and "observed the effect on children's constructions."

3. Results and discussion. Prediagonal children recognize the diagonal as an overall configuration and the parts in isolation. Ten children tested for "knowledge of parts of the diagonal" performed the task with only 5 percent errors. These and earlier findings are interpreted as supporting the view that an independent knowledge of whole and of parts is insufficient to guide diagonal construction. The transition phase is viewed as establishing "a system of relationships between the whole and its components, such that the relations between them are stable and explicit [p. 66]."

Study F (Nonsequential Diagonality)

Nine prediagonal and five diagonal children were required to position a rod to match vertical, horizontal, and diagonal patterns. Error was defined in unsigned degrees of displacement. The prediagonal and diagonal children performed about equally well. Hence, what seems to separate prediagonal and diagonal children performing checkerboard-referenced sequential diagonal construction is ability to handle the sequential aspect of the task.

SUMMARY OF EARLIER STUDIES

Olson's orientation following the studies described above is conveyed in the terminal half of Chapter 5, pp. 74-75.

> The conceptual systems that permit the seeing of the configuration in terms of a concept and attributes is [sic] invented and communicated to the child as a way of viewing or representing that configuration. In other words, even simple geometric concepts are invented and then imposed on the world as ways of representing that world; they do not arise simply from looking at that world. [There are] two important limitations [to] this argument . . . First, it is not simply a problem of telling or communicating; a child of two or three years is not much influenced by that telling. The child appears unable to 'hold' systems of this type until four or five years of age . . . strongly [suggesting] a large maturational component in the development of this system. Second [the argument is limited by the fact that some children apparently were able] to construct the diagonal the first time they ever saw such a piece of equipment [as a checkerboard].

Study G (Effects of Instruction II)

Findings are published elsewhere: Olson, D.R. From Perceiving to Performing the Diagonal. In D.R. Olson & S. Paglioso (Eds.) From Perceiving to Performing: An Aspect of Cognitive Growth. Ontario J. educ. Res., Special Issue, 1968, 10 (3), 155-236.

1. Problem. Three issues were studied: a) whether instruction that teaches the child to represent the diagonal in terms of its attributes facilitates diagonal construction, b) whether language is a necessary component of such instruction, and c) whether the representation used in instruction is equivalent to the perception of attributes.

2. Subjects. One group of Ss was 16 of the children used previously in Experiment E. A second group was 40 children drawn from a larger group of nursery school and kindergarten children, the larger group ranging in age from 37 to 73 months. All Ss could construct top row and middle column patterns but not a diagonal pattern.

3. Materials. A checkerboard and two sets of 5-inch square cards--10 per set--were used. Half of a set (or deck) had diagonal patterns; the other half were nondiagonal for one of the following reasons: a) did not begin at a corner, b) did not go straight across, c) did not end at opposite corner, d) descended in steps about the diagonal, e) was parallel to diagonal but displaced. Set 1 cards used checker-like dots to form the patterns; Set 2 cards, pictures of small objects. While dots and objects varied in size, color, and number from card to card, these markers were homogeneous on any one card. Each deck began with a diagonal card that E stated was a crisscross. S's task was then to sort the remaining cards into diagonal-nondiagonal piles. Errors were critiqued as made by the statement "No, this is not a crisscross." (If critiquing was effective, then it would be expected that error tendencies would diminish over responses of any trial.)

4. Procedure.

   a. Group 1 (N = 16). S sorted Set 1 cards under correction procedure, then attempted to match a diagonal pattern on the checkerboard (the model presumably out of sight). If unable to do so, S sorted Set 2 cards and then again attempted to construct the diagonal on the checkerboard. Procedure was repeated "for four to six trials, or until the child succeeded."

   b. Group 2 (N = 40). Group 2 children were divided into four subgroups of 10 Ss. (Groups 1 and 2 belong to independent phases of the study.)

(1) Group 2.1 (retested control group). These children sorted cards of irrelevant decks while experimental children sorted cards having diagonals and nondiagonals.

(2) Group 2.2 (primary experimental group). These children were trained and tested as in Phase 1 (like Group 1).

(3) Group 2.3 (question-answer plus card-sorting group). Procedure followed that for Group 2.2 except that wrong card-sorting responses led E to ask why the pattern was not a diagonal and, if S could not answer, led E to provide the answer.

(4) Group 2.4 (question-answer group). This group had no card-sorting task but S was asked the same sorts of questions referencing to a pattern on a card and provided the answer if unable to give it.

5. Results.

a. Group 1. Ss gave almost errorless performance on the card-sorting task, almost from the outset (Trial 1). In spite of overlearning on this task, performance on the diagonal construction task continued poor--only one child learned to construct the diagonal over four blocks of 10 trials on the board.

b. Group 2. All children failed a pretest, signifying inability to construct the diagonal. Seven each of Groups 2.1 and 2.2 failed a posttest (nonsignificant at the .05 level using McNemar's test for significance of changes). Four each of Groups 2.3 and 2.4 failed a posttest (significant improvement at the .05 level).

6. Discussion. Results are interpreted as consonant with the view that verbal instruction is a necessary condition to improved criterion performance. That is, when language is used to relate the perceptual components, then there is an appreciable positive effect on criterion performance. Two somewhat related statements offered by Olson (p. 87) are:

a. "Processes that are conventionally labeled as perceptual in education and clinical settings, such as copying of patterns on the Bender-Gestalt, may, in fact, be more adequately considered as representational or conceptual." This view is based on improvement of the verbal training subgroups (2.3, 2.4).

b. "The assumption is that, given a certain minimum level of motor skills, one's ability to copy a pattern is more a function of his vocabulary for representing forms than of his correct perceptual image. It is this strong position that is examined in the next training experiment and is found to be at least partially invalid."

7. Commentary. Recall that the chance probability for constructing the diagonal on the square board by placing five checkers in acceptable sequence is quite low. Even if we sharply reduce the patterns to those that can be constructed from the 13 recesses falling on the diagonal or immediately adjacent to it, then exclusive of the effects of a sequencing requirement, chance probability is 1/143, or .007. If it could be measured, we would expect a control group member to be .007 successful on pretest and posttest (assuming no learning to learn). Yet, based on group performance, the control group member was .3 successful on the posttest. For the control group as a whole, we would predict .07 performance on the posttest, whereas 3.0 performance was obtained. The following contentions seem worth entertaining: a) Suitably evaluated, improvement of the nonverbal groups (2.1, 2.2) is statistically significant. b) There was a security leak to the control group. Found tenable, these contentions would overturn the dichotomous view that nonverbal instruction will not suffice while verbal instruction will. (Olson is going to overturn the view anyway in Study H.)

8. Diagonal construction as a function of age. The "universes" from which Study G children were drawn contained children both of the prediagonal culture (the Study G Ss) and of the diagonal culture. Those of the diagonal culture are represented by chronological age in Olson's Table 6-1. Table 7 presents these data with additional data derived from or projected from those provided by Olson. Group 1 comes from the universe of Sample 1; Group 2, from that of Sample 2.

Table 7

Pretrained Diagonal Construction as a Function of Age for Counterparts to Prediagonal Groups of Study G

	Sample 1			Sample 2		
Age	Number	Number Correct	Percentage Correct	Number	Number Correct	Percentage Correct
2	7	0	0	--	--	(6)*
3	18	3	16	29	9	31
4	5	2	40	65	40	61
5	3	2	67	35	31	91
6	—	--	(85)*	3	3	100

*Projected value, assuming function has sigmoidal form.

The data base is shaky owing to paucity of N for some levels for either sample. Moreover, it is not certain that characteristics of children of the prediagonal culture are indicated by those for children of the diagonal culture. However, these data plant the suspicion that the populations underlying Groups 1 and 2 reflect subcultures that are differentially experienced with regard to spatial concepts. Transition culture representation then too might be differential. Were that so, it would prove somewhat inapt to make cross-study comparisons in research programs such as Olson's.

Study H (Effects of Instruction III)

1. Problem. What sort of training--for example, perceptual-motor, verbal--underlies acquisition of diagonality in younger Ss?

2. Background. Olson presents the following alternative views on effects of verbal and nonverbal experience on concept learning.

   a. Vygotsky. " . . . logical thought and systematic, hierarchically organized conceptual systems developed because of, and through, the learning of 'scientific concepts' which were the formal subject matter of the schools. The highest form of thought, verbal thought, was internalized speech which proceeded on the basis of the pure meanings of words. Hence, systematic organized thought was verbally regulated [p. 88]."

Luria, working within such a framework, found that he could get children to attend to changed ground characteristics using verbal commands which, when withheld, found the child attending to figure but not ground. He "concluded that language altered the natural strength of the stimuli, and as the child comes to generate his own language he can modify the stimuli he responds to; this gives his behavior a planned or volitional character [p. 88]."

b. Bruner. While Vygotsky's views may describe a terminal state, during stages en route to the terminal state "experience is coded first 'enactively' and later 'iconically.' For example, the child first learns a substrate of knowledge via his motor activity which underlies his visual and spatial, or iconic, knowledge. Both of these may subsequently provide the basis for his verbally coded or symbolic knowledge. It is not clear from the account how the earlier forms of knowledge are translated into or even relevant to the symbolic knowledge that develops [p. 89]."

c. Behavioristic views. These concentrate on experience-based (or psychomotor, or enactive) learning. They ignore language-based learning, particularly when the language is packaged as instruction. Olson shares the view (Premack, D. & Schwartz, A. Preparations for discussing behaviorism with chimpanzee. In F. Smith & G.A. Miller (Eds.) The Genesis of Language: A Psycholinguistic Approach. Cambridge, Mass: M.I.T. Press, 1966, p. 298) that "Organisms without language can be trained, but those with language can be instructed."

d. Dewey. Experience causes intelligence to develop, but how is not made clear.

e. Piaget. Sensorimotor experience is favored over language-based instruction as the route to development of intellectual schemas. Piaget fears language-based instruction as a means of indoctrination; when it is used, "it is of a strikingly nondirective nature [p. 89]."

f. Olson. "Language affect[s] memory primarily by directing attention [p. 89]."

3. Phase 1.

a. Subjects. Ss were 22 nursery school children who could do top and bottom row and middle column constructions and "were able to place three or fewer checkers correctly in the diagonal" construction task. Mean age for the experimental group (N = 12) was 46 months; for the control group (N = 10), 43 months.

b. Procedure.

(1) Experimental group training. A 30-inch square was formed on the floor, with representations of a duck, bear, rabbit, or cow at each corner. S was tested for identification of animals and required to walk around the square three times after being told it was a square. Then E pointed out corners and had them counted. Then a diagonal strip was laid; E noted that it went from corner to opposite corner and was called a criss-cross. Finally, S was required to roll a ball across the diagonal after the strip was removed.

Then S learned to draw a diagonal through a 15-inch square outline with animals portrayed at the corners, with assistance as needed. Then S learned to draw a diagonal through an 8-inch square outline formed by sandpaper edges after first feeling his way around the square and across a sandpaper diagonal.

Finally, S was required to draw a diagonal across an 8-inch square of paper and then to cut the paper along the diagonal. Training was given for three successive days. A posttest was administered on the fourth day.

(2) Control group training. Materials were the same except that diagonals were missing. "No concepts were explicitly taught, neither square nor diagonal." This group could be characterized as a sensorimotor group sans diagonal training. Procedure otherwise followed that for the experimental group.

(3) Posttest. Warmup tasks were top horizontal, middle vertical, and bottom horizontal patterns on a checkerboard. Following warmup, S attempted to construct left- and right-oriented diagonals, with a second trial in case of failure. Reversals were not considered incorrect. Performance was scored in terms of percentage of checkers correctly placed. Success was defined as 80 percent or more correct placements.

c. Results. Twenty-five percent of the experimental group and 20 percent of the control group (three and two Ss, respectively) succeeded. Olson characterizes training as "remarkably ineffective."

d. Discussion. Olson's first hypothesis was that conceptual learning underlying diagonal construction stems from "codification of the child's knowledge into language." Following Phase 1 of Study H, he shifted to the alternative view that language is only one of a variety of means for directing the child's attention to what the attributes of a diagonal are and how they are interrelated. According to this view, an earlier schema of Ss can be modified using various pedagogical means, one of which is language. Evidence favoring this view includes the following: a) A constrasting corner checker may be used to articulate the notion that the diagonal "begins at a corner." (But does it?) b) 5-year-olds able to construct the diagonal cannot describe the operation. c) Poor diagonal construction in East Africa is in part due to geometric impoverishment (of environment and, hence, culture). d) The learning of diagonal construction is facilitated by a nonverbal educational toy. e) Second-trial retesting facilitates diagonal construction and is a function of age. f) A Montessori nonverbal instructional approach yields about as good performance as a method employing language.

4. Phase 2. Phase 2 research is perhaps a classical example of the clinical investigation. It would take a good deal of time to obtain a reasonably accurate account of what went on. One suspects that the cake would not be worth the candle.

   a. Subjects and procedures. Most children who failed to reach criterion during Phase 1 received additional training specifically designed to teach diagonal construction referencing to the checkerboard. The child was shown "how a continuous diagonal line could be composed of a set of spaced, discrete objects [checkers] in the context of the checkerboard on which [he was] to make his productions [p. 102]." Pretest scores (presumably based on Phase 1 criterion performance on the five-by-five board) were available. These ranged from 0 to 60% (three correct placements). For 11 Phase 1 experimental Ss carried to completion of Phase 2, average pretest correct placements were just under one; for eight control Ss, just over one. For each Phase 1 group, four Ss had nonzero pretest scores. Following Phase 2 training--common to both Phase 1 groups--S was retested on five-by-five and seven-by-seven boards, with the success criterion being 80% for the former board and 71% for the latter. (The comparability of one error in a five-checker response and two in a seven-checker response is not obvious and not commented on.)

b. Results. One might predict that the two groups would profit equally from Phase 2 training. However, 7 of 11 of the Phase 1 experimental Ss performed acceptably by the end of Phase 2, whereas only 2 of 8 of the Phase 1 control Ss did so. In short, there was a Phase 1-Phase 2 training interaction.

c. Discussion. Once more, Olson finds continuous and discrete diagonal construction tasks to be different ones for younger children. "Children who could draw the diagonal on paper after instruction could not construct it on the checkerboard, thereby implicating the medium [i.e., the checkerboard] in which they were working [p. 104]." Of 11 Ss with pretest scores of zero, 6 remained zero at the end of Phase 2, 4 reached criterion, and 1 reached a part score short of criterion. Olson speculates on operation of a readiness factor, apparently on the basis of these data.

d. Commentary. As reported, Phase 2 research provides little basis for confident generalizations. If readiness is defined in terms of persistent nonprogress in face of superb instruction, then it appears tenable that readiness to construct diagonals will turn out a useful concept. At a point in research to establish what instructional factors may underlie the child's graduating from the nondiagonal to the transition culture, it seems premature to take seriously any invocation of the readiness concept. That is, it may well prove viable; however, the empiricist who uses it too soon may be closing out just when the search gets focused.

Study I (Effects of Montessori Instruction)

1. Subjects and procedure. Ss were children aged 38 to 57 months who could do the warmup patterns but not the diagonal pattern. These children received 1 to 5 minutes of "Montessori training." This involved showing the child the incorrect alternatives--by moving the checker about the board and shaking the head negatively--before placing the checker in correct position and shaking the head positively. Each placement so effected consumed on the order of 5 seconds.

2. Results. This "nonverbal" instruction yielded 50 percent posttest success; all who passed the posttest transferred to the opposite diagonal. Failure is reported as seeming a function of S's unwillingness to attend to training.

3. Discussion. The conclusion is reached that "at some level the information obtained from watching a good demonstration, hearing a comprehensible sentence, and from the feedback

from one's own performance are equivalent [p. 108]." That is, the form that pedagogy takes is less critical than the information that the pedagogy conveys.

4. Commentary. Olson's conclusion seems the right one, however reached. The main problem it poses is one of isolating its precise domain. A performatory act specified, there may be equally efficient methods for conveying act configuration and organization. However, as Olson's work--addressing a conceptual system of modest complexity--attests, act specification itself poses a problem if that is to include an underlying conceptual organization--or rule system for showing attributes in their relevant relations. Olson's own false starts in designing instruction are evidence of the difficulty of reaching an appropriate view of such organization (whether this is "given" by the culture or not).

Study J (Diagonal Acquisition among Preindustrial Children)

Study J was performed and published or reported by Robert and Ruth Munroe. Olson appears to have larger objectives (for example, referencing to comparative linguistics) than just showing that children from a preindustrial culture which manifests geometric impoverishment will have difficulty with the diagonal construction task. However, the description of Study J to be presented will deal primarily with his evidence on that score.

1. Hypothesis. Olson hypothesizes that "intellectual development is . . . a matter of developing or differentiating those conceptual structures relevant to the demands of culture [p. 114]." Such structures are transmitted by adults to children through the schooling process, which is structured according to the adult view of the culture and of language for expressing this view.

   The Whorfian view is commented on at some length. For purposes of evaluating what data Olson reports, hypotheses of the Whorfian type can be safely ignored.

2. Cultures. The main cultural comparison is between the postindustrial--for example, Study B--and preindustrial cultures. A secondary comparison is between two Kenyan tribes. These tribes appear to differ primarily in wealth criteria; for the Logoli, it is land ownership; for the Kipsigis, cattle ownership. The tribes speak different languages. For both, the culture manifests few linear or rectangular shapes; houses are round; the land, largely unsurveyed, particularly for the Kipsigis.

3. Subjects. Ss were 143 children--97 Logoli, 46 Kipsigis--aged 5 to 13. 61 Ss never had gone to school, 17 had gone for one

year, 31 for two years, 19 for three years, and 16 for four years. (Summing to 144, these figures indicate the broadening effects of schooling on N.) Nine Ss were 5 to 6 years old, 29 were 7 years old, 21 were 8, 26 were 9, 20 were 10, 22 were 11, and 16 were 12 to 13. Sexes were approximately equal at each age level. (The data suggest schooling-tribe biases at the various age levels, particularly the 11-year-old level.)

4. Procedure. As in the earlier studies, the child was asked to copy a pattern, shown on E's checkerboard and then removed, on S's board. Patterns were top row, middle column, row next to bottom, first diagonal, second diagonal, X (crossed diagonals). Patterns were tested in the order inventoried (that is, in the order of difficulty found to characterize postindustrial children). S typically received two trials per pattern, with performance scored passing if at least one trial yielded criterion performance. Failure at a lower level in the assumed difficulty hierarchy was taken to signify failure at higher levels. In consequence, 26 Ss, failing below the level of the diagonals, were not tested at that level.

5. Results. A multiple regression analysis revealed that "age, schooling and tribe made significant independent contributions toward accounting for the performance of children on the first diagonal; years of schooling and sex . . . on the second diagonal [p. 120]." The dominant factor was years of schooling (whose influence was westernizing in conceptual senses). In the age 5 to 7 range, 20 percent succeeded in copying the diagonal, in the 10 to 13 range, 70 percent. By contrast, all Canadian 6-year-olds succeeded.

6. Discussion. The different demands of East African and western culture are taken to account for the difference between cultures. In consequence of these different demands, East African children do not play with geometric games; their languages name few geometric concepts; etc.

7. Commentary. Several anomalies show up in the data. The performance of older children, particularly 11-year-olds, is appreciably poorer than that for 10-year-olds. This is particularly true for interior row, diagonal, and X patterns. Since performance tends to improve with schooling, tribe, and sex and sexes are approximately equally represented across age levels, the sample of 11-year-olds must have been biased regarding schooling or tribe.

There is nothing in Olson's account to indicate either that E failed to communicate the task or that S was withholding performance. Although Olson does not specifically remove the racial factor, it would be surprising to find that those blacks who are in the postindustrial culture of Olson's racially-unidentified

American and Canadian Ss performed differently than do the Study B Ss. These factors removed, then Study J can be taken to provide conclusive evidence that culture controls culture-defined performance. Unlike some, Olson avoids saying that the conceptual systems valued by the postindustrial culture have nothing particular to recommend them. They do--for a postindustrial culture. Rather, his position is that the utility of one culture's Euclidean space is matched by the utility of another's stealing game away from cheetahs. The preindustrialist is stupid about diagonals; the postindustrialist at least equally stupid about conning cheetahs. (We all can imagine the cross-cultural study that these comments imply. In such a study, it appears probable that it will turn out easier to recruit E from the postindustrial culture than S.)

Study K (Eye-Movement Research)

1. Problem. The problem is to determine visual search patterns underlying recognition and reconstruction of representations of geometric patterns--particularly of diagonals and of X (crossed diagonals)--and of a house.

2. Subjects. Ss were 57 nursery and public school children aged 52 to 87 months.

3. Materials and apparatus. Visual search routines were referenced to geometric patterns--the diagonals and an X pattern in a five-by-five field--and a representation of a house. Visual search records were made with an eye-movement camera. When the performatory act was recognition, the child was to choose, from patterns presented to the right of the model, which pattern corresponded to that modelled. When the act was construction, the child attempted to construct the modelled pattern on a checkerboard to the model's right. A variant of the recognition task had the response alternatives shown before the model was shown. Eye movement records were obtained "only for the two trials on each diagonal and X pattern." After the geometric patterns were negotiated, 13 children were used in a recognition study involving house representations.

4. Procedure and results.

   a. Recognition of houses. S first saw a model representation of a house, then, in succession, four other representations, each differing from the model in one feature--missing door, chimney, etc. As each of these four representations was presented, the child was asked if it looked like the model (presumed removed following initial examination). If S said not, then he was asked why and scored correct if he identified the missing or different feature. The series then was negotiated a second time in identical order. On each series or trial, five older children and eight younger children were tested, contributing, respectively, 20 and 32 judgments per trial. On the first trial, 65% (13) of the judgments of older Ss were correct; 19% (6) of the judgments of younger Ss were correct (difference significant at the .01 level). On the second trial, older Ss were 85% correct; younger Ss, 33% correct (difference significant at the .01 level). "Again the youngest children tend not to notice the single altered feature when the search is on the basis of memory. This corresponds to Vurpillot's . . . finding that both younger and older children do well in recognizing things to be similar, but younger children do less well in judging them to be different--presemably [sic] because of the less adequate visual search [p. 139]." Eye-movement records show that four of the five older Ss focused on all 4 critical features during model viewing, whereas only one or eight younger Ss did so. Mean features fixated by older children were 3.6; those for younger children, 2.6 (difference significant at the .02 level). Surprisingly, features fixated on the model did not predict well the absent features whose position would be fixated during judgment trials. Moreover, amount of search appeared to bear no systematic relation to accuracy of judgment. Fixation time was somewhat greater for younger than for older Ss (difference significant at the .01 level).

b. Supplemental recognition of houses. Four of the younger Ss received supplemental training which directed them to the critical features. Knowing what to look for, the tutored younger Ss exhibited search patterns corresponding to those of the untutored older children. (Presumably their judgments improved accordingly. Whether fixation time--both here and above--relates entirely to perceptual activity--looking--or includes a functionally-blind reflective component cannot be ascertained. Olson notes that both may be operative.)

c. Recognition of geometric patterns. After viewing the model, S was required to judge which of two alternatives was like the model. For the diagonal pattern, the unlike alternative had its lowest checker displaced one position. On Trial 1, 85% of the judgments of 13 6- and 7-year-old Ss and 33% of the judgments of 12 4- and 5-year-old Ss were correct (difference significant at the .01 level); this in spite of the fact that younger Ss fixated longer and neither group tended to fixate on the critical feature (the bottom checker) of the model. On Trial 2 both groups knew what to look for. Both groups increased fixations of the critical feature--from an average of 20% on Trial 1 to an average of approximately 60% on Trial 2. Both were 100% correct on Trial 2 judgments. Ignoring age, the 10 children who judged incorrectly had significantly more fixations than the 15 who judged correctly on Trial 1. The data for X pattern recognition is not helpful because all but one child judged correctly on Trial 1 when the X pattern was the model.

d. Construction of geometric patterns. The instruction to search a diagonal model preparatory to constructing it had the effect of causing search to be longer and search time better to predict performance. Those who succeeded in constructing the X pattern searched longer than those who did not. Thus, results tended to be the inverse for recognition findings when referenced to search time.

5. Discussion. "Visual search . . . follows the pattern that Garner . . . finds to be characteristic of perception in general; specifically, . . . the perception of an event is a function of the perceived or inferred set of alternatives. The alternatives being entertained by the viewer account for another observation that would otherwise be anomalous. Once the children knew that the presence or absence of the chimney provided information for their judgments, they looked for the chimney even when it was absent . . . One is hard pressed to describe this behavior . . . the stimulus is absent . . . there is no stimulus to notice. These observations are comprehensible in terms of the hypothesis that the viewer has expectations of the alternatives, and even the nonoccurance of an event may provide information to choose between these alternatives. This property of perception has previously been described by Sokolov . . ., as the missing stimulus effect [p. 153]."

Olson goes on to state that "The important effects of the set of alternatives on recognition . . . would necessitate some revision of the relation between recognition and production, or perceiving and performing [p. 154]." Both sorts of tasks turn on the set of alternatives within which one must choose. However, in the recognition task, S does not (beforehand) know what the alternatives are. That might account for why more time is spent in looking at the model during the production task.

6. Conclusions. Olson's major conclusion is that "older children make a more accurate estimate of the alternatives that are likely to occur and . . . anticipate the potential relevance of a set of features for choosing among this larger set of alternatives [p. 157]." That is, even before the recognition task is made known in terms of alternatives to be judged, the older child is using both general form features and detail features as points of focus, whereas the younger child is using only the former.

7. Commentary. The records and Olson's discussion strongly suggest that general form can be perceived on the basis of peripheral

involvement. The eye-movement camera is assumed to record foveal involvement. Not all of the general or detailed features of a pattern need fall on the fovea to insure accurate judgment of similarlity or dissimilarity.

Chapter 9 (Effects of an Educational Toy . . .)

It is recommended that the reader form his own judgment of the value of Olson's Chapter 9 to our understanding of the process by which the diagonality concept is acquired.

SOME ASPECTS OF A THEORY OF COGNITIVE DEVELOPMENT

Olson uses his own findings and views and those of a larger literature to reach elements of a theoretical position. This position is presented in Chapter 10 under the headings of perception, language, perceiving and performing, intelligence, and instruction. His views on intelligence are largely covered above; those on instruction are extremely sketchy. Remarks that follow will primarily address the first three of the headings.

Perception

1. <u>Cue Specificity = f (age)</u>.

   a. Description of the function. As the child develops, his performatory acts shift from being primarily directed by more general topological cues--for example, edgedness, proximity, configuration--to being increasingly directed by more specific cues. In the context of formation of the diagonality concept, the more specific cues are those of Euclidean space--for example, line direction, number of angles, angular size.

   b. An attempt to explain origin of primitive cues. Younger children and octopuses find horizontal lines and vertical lines easier to distinguish than oppositely-oriented oblique lines. The child eventually develops beyond this level but the octopus never does and in fact forever confuses any obliquely-oriented line with either a horizontal or a vertical line. Olson asserts that the child's earliest greater skill with horizontal and vertical lines stems from relative <u>cue invariance</u> inherent in perceiving these lines. If one views such lines in three-dimensional space, then the different ways they may be viewed are related to their possible mirror images. The horizontal and vertical lines have fewer possible mirror images referencing to three-dimensional space than do oblique lines. Hence, they afford child and octopus greater cue invariance during execution of such interspecies performatory acts as locomotion and grasping. For the octopus and for the child of limited experience, the less variant cues have (greatest) ecological validity.

Cue invariance and ecological validity concepts apparently themselves are a function of experience. The younger child perceives cue invariance with respect to those spatial factors that aid the precultural activities of locomotion and grasping. The same child later will perceive cue invariances that are relevant to the execution of performatory acts of a more cultural nature. If this is correct, then cue invariance and ecological validity concepts describe, respectively, <u>means</u> and <u>ends</u> referencing to the performatory act.

Means and ends both may be viewed as consequent to two sorts of factors--those that are wired into the species and those that are a product of individual experience, whether culturally or more narrowly based. In consequence of retinal studies for lower animal forms, Olson suggests that the distribution of specialized cells receptive to horizontal, vertical, and oblique line orientations may account for the lifetime tendency of the octopus and the early tendency of the child to have performatory acts directed by vertical and horizontal line orientations. The earliest perceptual cues used, then, arise from wired-in predispositions to sense certain information in the display or milieu in the service of performatory acts whose configurations also are wired in, or bounded, by the gross anatomy.

2. <u>Performatory act = f (contrast set characteristics)</u>.

   a. Description of the function. The contrast set is experientially defined on the stimulus to be perceived. "Garner . . . pointed out that what one perceives in a stimulus is a function of the perceived and inferred set of alternatives, that is, the contrast set . . . [Thus] the feature that one detects is always a function of the set of alternatives [pp. 175-76]." A younger child appears to perceive a pattern--for example, an oriented line--as having "a small set of alternatives which differ in terms of such topological features as general configuration, including open-closed, straight-curved, and so on [p. 176]." Older children "perceive an event in terms of a much larger set of alternatives . . . [including subtle features such] as direction of line, size and number of angles, and so on [p. 176]."

   b. An attempt to explain development of feature selection. Why are more specific cues selected with increasing age? In Olson's view, it is "because they provide information for the guidance of a performatory act such as locomotion or reading [pp. 176-77]." More is involved than that these cues are discriminable in the stimulus. They become potent organizers of perception on acquiring ecological validity, that is, by showing that they are means to an end that someone desires.

c. Commentary. Although it has a teleological ring, one is tempted to summarize Olson's views thus far as "survival of the fittest cues." Just how does utility account for an individual selecting, at any point in development, from the set of cues that are potential to perception? Olson attributes the increasing directing power of more specific cues to culture--that is, to the effects of such trappings of culture as language, schooling, and media. Whoever or whatev. sets standards of performance, Olson views the child as trading in one schema of perceptual organization for another if (after a time) it becomes evident that the earlier schema does not gain specified performance objectives.

Language

1. The Whorfian hypothesis. Whorf (1956) postulated that linguistic structure is causal to how one conceives physical reality. Thus, he imputed to the Zuni language the basis for a Zuni view of time and concluded that no Zuni ever would have invented the Einsteinian view of physical reality.

   a. Olson's view. In earlier chapters, Olson comments favorably on Whorf, perhaps because Whorf was a cultural relativist. Here he rejects the Whorfian view that language is causal to perception and conceptualization. Rather, Olson believes that language reflects something about how perception will develop. Olson views linguistic structure--or rather lexicon--as developing in consequence of "the information value or ecological validity of the perceptual cues in differentiating among alternatives [p. 179]." The lexicon of English contains single words describing vertical and horizontal vectors--up, down, left, right--with regard to orientation of direction, but no single words for similarly describing oblique vectors. If this bias of the lexicon of English were causal regarding perceptual development, then it might account for why younger children perceive or make use of information referencing to horizontal and vertical lines. Since the octopus has a lifelong tendency to use such information and never reaches a point where the information referencing to oblique line orientations is used, lexicon cannot be considered causal.

b. Commentary. In Olson's hands, the concept of culture too often seems to refer to that which separates or differentiates members or groupings within the species. But the different cultures of man have many points in common. They share language, even though a Chinese language may be long on syntax and short on morphology and a Polynesian language just the opposite. Much of the Chomskian view of linguistic predispositions is based on comparative linguistic analysis. Without commenting on where common elements of linguistic structure across cultures arise, existence of a "universal base grammar" works against both the Whorfian view and the view that a particular language--for example, English--alone will show what is consequential to establishment of "the ecological validity of perceptual cues." It does not appear appropriate to search through the lexicon of <u>English</u> for evidence why, in the species, horizontal and vertical lines and vectors should be more primitive than oblique lines and vectors. If it were shown that, for all languages, there are common lexical biases in favor of the horizontal and vertical line orientations, then we might agree with Olson that lexicon provides one basis for discovering clues to how perceptual hierarchies are organized when the ordinate reflects a measure of human development. A review of the lexicon of English is insufficient to this quest.

2. <u>Perceptual hierarchy</u>.

a. Exemplars. Olson presents two alternative models of "the structure of the perceptual and semantic system" for line orientation (Figure 10-2, Figure 10-3). For both of these models, the ordinate appears to reflect two sorts of information: a) that of a word-to-phrase dimension, with covarying familiarity implied, and b) that of superordinate-to-subordinate subsumption based on class concepts. Some indication of how more complex displays derive from more primitive ones is indicated at the lexical level by derivation of the phrase "up to the right" from the words "up" and "right" (and English syntax) to characterize an ascending right-oriented oblique vector.

b. Commentary. That children's utterances tend to develop from single-word sentences to longer ones seems established, but it is by no means clear that the child's system of signification matches his utterances in the same way that an adult's system of signification matches his. Moreover, it would be a very linguistically impoverished child aged 3 to 5 who was not well along the route to extensive phrase-clause-level proficiency. It is rather difficult to entertain the view that prediagonal <u>S</u>s aged 3 to 5 fail to construct the diagonal because they lack proficiency in dealing with patterns that can, in English, only be described using short phrases whose form and lexicon seem common. This is not to argue that there might not be a point in early development where the child's lexicon and phrase-level syntax are inconsonant with naming diagonals or reacting to phrase names supplied by an instructor. Nor is it to argue that presence or absence of single-word names in common use might not be appreciably related to perception very early in development. Perhaps we can emancipate Olson's view somewhat from level of syntax by formulating a view of the naming utterance as consonant with most or all levels of syntax that could be used to form names. Viewed in that light, name accessability should have something to do with the developmental ordering of cues from more-general to more-specific (and on eventually to ultimately-specific as culture defines this).

3. Commentary. The notion that performatory acts common to the species influence the development of a "universal base grammar" is attractive. Some of these acts will classify as precultural in the sense that they are shared by other species; some will be cultural (in the cross-cultural sense) because shared by no other species. For performatory acts that are defined by a given culture, it would seem attractive that the development of the language of that culture would be influenced by such acts. Given such a view of the relation of language to performatory acts found useful by the species or the culture, then it may be that language in the hands of a taskmaster makes a fundamental or primitive contribution to feature selection that is further back in development than the region that Olson has searched so patiently. Perhaps the most basic concept that language in the hands of an agent of culture imposes on the child is the one that Helen Keller teased with such great effort from our universe--that, among men, all things, states, and processes, whether existing or hypothetical, have names. True, a phenomenon of interest to a culture may have many names and a name may be used to characterize more than one phenomenon. Nevertheless, Miss Keller tells us that the naming concept was the watershed she had to cross before she could move, as most children do, with increasing assurance into those particular domains of activity that characterize all of the cultures of man and, as yet it appears, no other species. Robbed of retina and cochlea containing functional specialized receptor cells from a very early age, how did Helen Keller, years later, break through to the concept that all things have names? Quite probably not by using extrasensory perception. But neither apparently by building up her syntax. For her apparently the naming concept was formed at the very fountainhead of syntactic development; her experience appears to reverse Genesis and St. John in supporting the view "First the light and then the word."

Perceiving and Performing

Under this heading, Olson a) distinguishes between perceiving, recognizing, and constructing a pattern, b) discusses the effects on perception of looking or searching activity referencing to the pattern and of prior execution of the performatory act, and c) presents the view that perception and representation are facets of one system. The commentary to be delivered with regard to Olson's views presented under this heading are sufficiently extensive that comments will be deferred to a later section.

1. Perceiving-recognizing versus constructing. Perceiving and recognizing a pattern are not synonymous. Pattern recognition is a function of the number of alternatives to be discriminated; if the alternatives are only slightly different than a pattern to be recognized, then a younger child might not recognize it. According to this view, recognition is a response or performatory act that might require the processing of little or of much information. Perceiving is a response or performatory act that picks up some or all of the information underlying recognition. Construction requires more information and, often or always, different information than recognition does. "Performing an act such as copying, making, or speaking, requires different perceptual information than the act of perceiving or recognizing an event amongst a set of simple alternatives [p. 183]."

   To anticipate Olson's later comments, a requirement to recognize a pattern on the basis of a few grossly different alternatives may be distinguished from other requirements: a) to recognize the pattern on the basis of many similar alternatives, b) to construct the pattern to reflect its general features, c) to construct the pattern based on both its general and specific features. The required perceptual activity is a function of the required performatory act. That is, the different performance requirements call for differently directed perceptual activity. Older children, uninformed concerning the purpose of perceptual activity, hedge against a wider range of possible performance requirements than do younger children. That is, older children take in more information bearing on a wider range of performances. When given some indication concerning what the terminal performance will be, older children more effectively and efficiently employ perceptual activity to obtain the relevant information than do younger children (witness the eye-movement research).

2. Effects on perception.

   a. Model-viewing effects. Younger children instructed to look at the model preparatory to construction perceive the topological cues of edgedness, proximity, and configuration, which suffice for construction of more primitive patterns but not derived patterns. Moreover, when the performatory act is defined on one medium--for example, that of diagonal drawing--performance does not transfer to another medium--for example, that of checkerboard diagonal construction.

b. Performatory act effects. What causes the set of perceptual features considered by S to grow? In Olson's words, "Just as learning to differentiate an object from a larger set of alternatives leads one to know more distinguishing features of that object, so learning to carry out new kinds of performatory activities in relation to that object leads one to know more or different features of that object. [Thus] one requires different information to catch a ball (will it take one hand or two?) than to discriminate it from a cup, or to draw it, or to name it [p. 185]." Olson adds that "early perception appears to be attuned primarily to features which are invariant in the performatory acts of locomotion and grasping [p. 186].

One or more performatory acts occurring under one or more circumstances yield experience. The effects of experience are information. What is the status of this information? Olson says that the information obtained is perceptual information rather than response information (if there is any such thing). "[An] attempted performatory act merely provide[s] the occasion for picking up new cues [about the world]. At least one part of the information one has about the world is therefore a function of one's performatory attempts at walking and grasping [p. 186]."

3. Perception and representation as facets of one system.

a. Status of representation. Piaget and Inhelder believe that such activities as form-copying depend on "representational knowledge . . . formed by internalized activity [Olson, p. 187]." Olson believes that the Piaget-Inhelder view confuses ends with means. What Olson believes gets internalized is "that the performance of the motor act requires information for its guidance [p. 189]." In Olson's view, "there are . . . not two independent systems, perceptual and representational, as Piaget has argued, but rather one system, a perceptual one, which is altered substantially by performatory acts in different media [p. 187]."

Olson clarifies his use of the term representation almost at book's end. ". . . the term representation was employed somewhat differently by both Gombrick . . . and

Arnheim (. . . who used it in terms of a performatory act such as 'using a circle to represent a man's head') than . . . by Piaget, Cassirer, Bruner, and Gibson. The latter use representation to refer to imaginal processes . . . that occur in the head, not on canvas or paper. In terms of the [Chapter 10] account . . , the former usage is more psychologically defensible. It is redundant to speak of representations in the head. Rather, attempts at the performatory acts of representation in art, and in language and other media, provide the occasion for obtaining much more information from the perceptual world . . . internalized activity is a similar misconstrual [pp. 196-97]."

b. The media. The media apparently include print, television, and other communication devices and such culture-invented systems, typically called conceptual, as the number system and Euclidean geometry. The checkerboard device used in many of Olson's studies, when suitably referenced to a performatory act, is a medium that derives from a Euclidean concept of space. Apparently, in Olson's hands, the medium alternatively is the conceptual system, constrains the conceptual system, or derives from a medium-constrained conceptual system.

c. Information and media. In Olson's view, information is partially but not completely medium-specific. Thus, "concepts are cognitive events specified by the linguistic medium just as certain patterns of guided movements may be considered as units in the medium of representational drawing . . . [whereas] information picked up in the context of the various media is not media-specific (but overlapping) [pp. 189-90]." Overlapping information appears illustrated by the communalities holding between checkerboard and paper square media referencing to the diagonality concept. One might perhaps say that information is defined on a conceptual system as this is reflected by one or more media.

d. Locus of information. "If someone is not aware of the alternatives, there is by definition no information. Hence, it is inappropriate to speak of all that information being in the stimulus to begin with [p. 191]." This view is an alternative to E. Gibson's view that "perception is a process of extracting the invariants in stimulus information [p. 190]."

4. Summary. "In the course of becoming sensitive to . . . decision points, and by gathering further information from the model, [the child's] perceptual knowledge of the model is elaborated. It is this back-acting effect of performance on perception that

artists [note] . . . it is the beginning of performatory attempts in such media as language and drawing that require for their execution the selection of new cues or information. In the contexts of these performatory attempts, the child's perceptual world becomes elaborated . . . It is reasonable to suggest that [the child's] development and mastery of more recent media of language, number, and art . . . account for his continuing evolution. At the level of individual development it is the acquisition of skills in these media that may be proposed as an account of the development of intelligence and, hence, to the substantial cognitive changes that occur about the time of the onset of schooling . . . [p. 192]."

Intelligence and Instruction

Olson's views on intelligence as skill in a cultural medium (or skills in the cultural media) have been presented earlier. Olson recognizes that theories of cognitive development will have to deal with instruction if they are to influence classroom practices directly or appreciably. However, he himself has little to say concerning an instructional theory or theoretical component. He notes that instructed activity "on some occasions" shows S what information underlies given performance more efficiently than does uninstructed activity, that such instruction may take verbal, nonverbal, or mixed form, and that there are certain constraints on effective verbal instruction.

Concluding Comments

The following general comments are noteworthy.

1. Theoretical position. "Although it is peripheral to my purpose it must be clear how far we have moved from a response-reinforcement theory of psychology. In my view, a person is not learning a response at all; he is elaborating his perceptual knowledge in the course of his performatory attempts in a medium. But it should also be noted how far this account is from perceptual theories that ignore the role of performatory acts in the elaboration of perceptual knowledge [p. 202]."

2. Position toward theoretical position. "It becomes obvious that we are now equipped with a whole new set of conjectures about the nature of intellectual development, conjectures that would probably serve better to introduce a volume than to conclude one [p. 203]." (This is the book's concluding sentence.)

GENERAL COMMENTARY

What is Olson saying, and what, if any, action-implications for education inhere in Olson's remarks?

PERFORMATORY ACTS VERSUS PERCEPTUAL ACTIVITIES

The performatory acts presumably are those that a current schema controls through efferent action. Such acts apparently are those involving the gross musculature, the eye and pupillary-lens musculature, and perhaps musculature that controls "orientation" of some of the other sensing devices. Since instruction has attentional effects and because a current schema also controls perceptual activities, there must also be an efferent component to perception. If we distinguish between perceptual and performatory acts, then the basis must be that perceptual acts involve, in addition to efferent control, an afferent system response--that is, reception or the picking up of information. It appears that those acts involving sensory orientation can be classed either as performatory or perceptual, depending on empirical intent. Likewise, a performatory act involving the gross musculature could be considered perceptual in the sense that such an act inevitably will trigger information transmission over surface and kinesthetic channels of the afferent system. That motor effects on a surrounding environment are what usually are studied does not argue that afferent outcomes referencing to these effects could not concurrently or even alternatively be studied. Hence, the distinction between perceptual and performatory acts is one of convenience or of assumed profitability.

OUTCOME OF THE PERFORMATORY ACT

Olson is largely silent concerning the nature of conditions that cause schema modification to occur. It appears tenable that usually, if not always, an individual will only trade in or modify an existing schema controlling a given performatory act if that schema is confronted with evidence that an attempt to perform the act fails to secure an objective or does so too slowly or at too great a cost in effort. That is, the occasion for modification of a schema is evidence that the act that it controls fails to meet criterion performance specifications.

One way to view the matter is to distinguish between cognitive (conceptual) and performance (perceptual, motor) components of an instructional system. The cognitive component then would deal with criterion specifications to be placed in the child's schematic store. Imperfectly placed, the schema would have to yield imperfect performance. That is, performance could be not more apt than whatever schema had been acquired and was in control of a given attempt to perform. If there are motor learning components to complex psychomotor activities--and there surely are--then acquisition of the terminal or criterion form of a schema would not necessarily be the occasion for criterion performance.

In passing, individuals concerned with educating children are not agreed on the extent to which the educational enterprise, grounded on given cultural views, should define the range of criterion performances to be placed in the child's store of schematics. This is hardly an either-or question. One criterion that the western cultures might reflect in their educational enterprises is analogous to the Shangri-La criterion of practicing moderation in all matters, including the matter of moderation. That is, while attempting to enter into the child's store those criteria that the society heretofore has found useful, the educational enterprise also would enter the rule that yesterday's meat may be tomorrow's poison, an invitation to treat all criteria as tentative and subject to revision.

A SCENARIO VIEW

The following view seems consonant with Olson's position. First, earlier experience bounded by sensorimotor givens and referencing to diverse media lays down a cognitive system or schema that is one's basis for performing with respect to some new set of conditions. Given such a schema, whenever employed and for whatever reason, the senses will pick up only information whose form is defined by that schema. When a performatory act is attempted under a new set of conditions, whatever the reason, if it succeeds, wherever the locus of criterion specifications, then the existing schema will be reinforced or confirmed. If not successful, then the act "will be the occasion" for modifying the schema. (If, as we argued above, an existing schema reflects an existing criterion on which _S_ operates, then schema confirmation under "changed conditions" indicates that these changed conditions are irrelevant in that they do not necessitate a modification of behavior. For skills of the academic type, Olson's work reinforces the view that _S_ will not perceive that his performance is unacceptable to someone--it is acceptable to _S_--unless that matter is signalled. In the typical instructional situation addressing an academic skill, it is that signal which is critical to schema modification underlying better performance. That is why one would quarrel with Olson's conceptualization of Experiment C. For in Experiment C, the signal to the trial-and-error group was ambiguous even when judged against the resources of an associationist view.)

The unsuccessful act is the occasion for a greater cogitative burst leading to a somewhat modified schema which then is tried out to determine whether acceptable performance results.

Such a view defines a learning construct as schema modification. It appears to assert that no successful act can be more than a demonstration of prior learning or schema modification. The successful act will make first use of that schema which defines the right kind of information. If one tests for _performance modification_ over trials, then it is probable that performance will modify frequently across trials when the skill is a complex one in light of the child's experience. If one tests for _criterion performance_, then learning will have a one-trial character; a given trial will result either in criterion performance or not.

The foregoing view asserts that evidence for learning is demonstrated progress from initial precriterion performance to criterion performance. If criterion performance is complex, then a proficiency hierarchy may be defined such that S ascends to criterion in stages that pass through lesser performatory acts that are so sequenced and interrelated as to culminate on a terminal criterion performance. In this event, one may seek evidence referencing to each of the subskills lying along the route to the terminal skill. Whether evaluation is based on terminal criterion skill or on performance relating to all skills along the route, there is no evidence of learning unless it is demonstrated beforehand that S has reason to modify an existing schema. The most straightforward way to collect this evidence is by giving S a test that he will fail. While it may be true that failure should be minimized, any need for instruction is predicated on the hypothesis that S's schematic store is inadequate to control desired performatory acts. This hypothesis can only be verified through causing S to attempt to perform an act and finding that the attempt is unsuccessful. Whether we charge the schools with instructing or S with learning for himself, S will learn nothing unless he finds cause to reject a current schema, or to sense failure in some sense.

OLSON'S ORIENTATION TO THE INFORMATION CONCEPT

Consider Olson's diagonal construction task, to be learned by prediagonal children aged 3 to 5 of the postindustrial culture. The five-by-five square board permits formation of a large number of patterns, only one of which matches the presented pattern. Where this pattern is one of the diagonals, it appears likely that many of the incorrect patterns would not be offered. Let us assume, as earlier, that the chance probability of producing the right pattern without respect to sequence is .007. This signifies that the pattern presented has an effective contrast set of 142 related but dissimilar patterns. While Olson does not prove that S can discriminate the correct pattern from each member of the contrast set, let us assume this so. The concept to be learned is not diagonality but rather diagonality as that is reflected in a single pattern that can be produced on the square board. If discrimination is an ineffective basis for correct production, then performance will be in the region of .007; if effective and efficient, then near unity on the first attempt to construct the diagonal. Olson's findings lend support to the supposition that discrimination will prove ineffective. His findings also lend support to the supposition that near-unity success will occur only if the child somehow relates parts to whole, with some sort of rule, however learned.

Olson's studies evidence only minimal concern with concept or rule transfer (to the opposite diagonal) or generalization (to some other medium that is consonant with the plane diagonality concept). However, let us concede at least that a rule learned with respect to constructing one diagonal on the square board will transfer to the opposite diagonal.

If it does so at the same near-unity performance level as original learning, then the rule has been learned in a properly-general form.

Consonant with Olson's views, ability to discriminate successfully indicates one level of information acquisition, ability to discriminate and to construct a given pattern, a second. However, ability to transfer as this is defined in the construction situation involves attending to still other information. That is, even square board diagonality is neutral on orientation of the pattern; however, diagonals cannot be constructed correctly without taking orientation into account. The conceptual information that ought to be transmitted to ensure transfer or generalization would not address the orientation dimension. However, correct construction always will require that perception code the pattern for orientation. Olson's construction task appears to raise information processing issues that would not arise in selection tasks.

This is of interest because in time we will want to know just how to teach a concept--for example, by focusing on its relevant attributes and their relations, its irrelevant characteristics as evidenced in a set of exemplars randomly drawn from its universe, characteristics of contrasting concepts, or a combination of these.

Neither Olson not I appear to be operating up to Garner's (1962) level of differentiation of uncertainty and structure. There appears to be much in the information--theoretic literature that should be brought to bear upon the concept learning domain. Rather than attempt that here, I will be content to constrast the information of concern to Olson--system information--with another kind--system state information. When I approach an intersection, I am uncertain what state the traffic light will be in when I get there. My schema for defining information with regard to the traffic-control system was validated long ago. Unless the traffic-control system changes, it will not ever be possible to learn anything new about that system. That being the case, when referenced to me, the traffic-control system contains no information about its form of organization. However, for everyone, such a system always contains state information, which is why we pay attention to traffic lights. Olson's repeated statements that new information will not be forthcoming until a schema is modified has reference to system information rather than system state information. Probability matching and games of chance are not uninformative to experienced players; having learned the system, such individuals must be concerning themselves with the state of the system.

TYPES OF LEARNING

Any class reflects a domain of applicability for its concept (see Langer, 1967). Non-null classes may contain anywhere from one member (the unit class) to all of an unspecified number of members (the universe class). Had an educator invented the unit class, he might well have given its member the characteristics of specificity and historicality. Consequently, an educator seeking to impart the information "x is a member of the class Mulberry Street" would mean "this here x" rather than "there exists an x such that x." Even so, the educator (or instructional systems designer) probably would pick up the implication that x belongs to the universe class of streets.

It seems likely, in education, that the following exemplary information-imparting requirements would be distinguished: a) x, a member of a class whose domain of applicability is previously learned, is the only member of a second class--e.g., Mulberry Street. b) x, a member of a class whose domain of applicability requires learning, is one member or exemplar of a large and perhaps nonexhaustible class--e.g., the diagonal class. The learning requirement typically is called associative in the first case and conceptual in the second.

What distinguishes a conceptual set of exemplars from an associative set is perhaps not that the associative set contains only one member and the conceptual set more than one member, but rather that members of the associative set are identities, whereas members of the conceptual set are not. It may be argued that all instances of the Mulberry Street label are not identical; however, they are identical for purposes of a contrastive definition of a conceptual set. The conceptual set of all people, called the human class, reflects both a communality of the membership (human) and a noncommunality (some eat octopuses, some speak Swahili, some wear wooden shoes, and some have lungs that function well at 14,000 feet). A fundamental question which Olson's description does not clarify is whether cognitive development encompasses both the learning of associations and of concepts.

CONCEPT-LEARNING INSTRUCTIONAL STRATEGIES

When we are able to quantify such matters better, it will probably be found that plane diagonality is an easier concept to teach than plane triangularity. However, even for diagonality, differences among universe exemplars are much greater than a square figure might reveal. Olson's construction task has to be modified when we move from a square matrix to a rectangular one; hence, at the level of rectangles, let us consider only continuous diagonals. Will instruction referencing to a square form generalize to tall, skinny rectangles and to short, fat ones? Will it generalize from instructional surfaces of paper and wood to the ground or sky or a painting in the Louvre (one by Rubens, where diagonal organization is clearly evident)? If not, what does Olson have to say concerning how instruction should proceed? Will there be a need to transition the child to a somewhat more "inductive" (although guided) instructional approach wherein the terminal performatory act is to pick out from an array exemplars of diagonality never before seen but within the instructional domain of applicability of the diagonal concept?

It would be grossly unfair to Olson to attempt to levy on his work a requirement that it show the way to efficient concept learning instructional strategies. Our only interest here is in indicating that his work did not move far into the diagonality concept and so has only limited bearing on the form that instruction on diagonality should take.

The view that experience controls perception and that the performatory act reflects such experience by showing us what the child perceives (and conceives) is a useful one having implications for education that some have perceived but none yet have exploited well. Given that the view can be exploited to tell us where a child is, experiencewise, on entry into given instruction, there remains the herculean task of determining how then to proceed.

SPECIAL ISSUES

CONCEPTS AS COGNITIVE EVENTS

Olson describes concepts as "cognitive events specified by the linguistic medium [p. 189]." Is the concept of diagonality specified by the linguistic medium or by a representation of Euclidean space (the Euclidean medium), or is Euclidean space itself a cognitive event specified by the linguistic medium? It would seem clearer to say that concepts are ways of analyzing and synthesizing facets of nature that a given culture or spokesmen for that culture have invented and codifed in the various systems that culture employs for such purposes. The child reaches a cultural post-matriculation when his performatory act reveals an ability to perform consonant with the cultural record in codified form. (One of this culture's concepts is discovery. While some encourage discovery performatory acts as the way to get into already-charted waters of the cultural record, a more apt sense of the discovery concept implies novel performatory acts that will either get the performer thrown into prison or an asylum, ignored, or lionized. Such acts are under the control of a Shangri-La corollary to all existing schemas--to entertain them at best as yesterday's guide to today's acts.)

That lower forms show some capability to transfer or generalize--as did perhaps Helen Keller before she discovered the linguistic medium as we know it--seems all the evidence that we need that concepts are not simply cognitive events specified by the linguistic medium.

Noted earlier, matches between the child's use of lexicon and syntax and that which culture sanctions do not necessarily indicate much about the child's semantics. But we need not confine ourselves to children in this regard. Social scientists who try to read each other know how far apart the semantic practices of even the members of a community of scholars can be. There are ways to minimize confusion regarding signification. However, inevitably these take us beyond the linguistic system (or medium). That is another reason why we cannot afford to allow a linguistic medium per se to define concepts.

PERCEPTUAL AND RESPONSE INFORMATION

Olson pretty well demonstrates in the square board diagonal construction situation that even younger Ss are capable of the required motor activity but simply are not picking up all of the relevant information. Consider, however, tracking a target on a pursuit rotor or controlling a wire-guided ground-to-ground missile. If we mean by perceptual information that telling S where the target and tracking devices are, then perhaps such information is sufficient at the outset of instruction or soon thereafter. The thing that appears most in need of learning when such tasks are to be performed is proper synchronization of the musculature consonant with the perceptual feedback, so that the tracking device will stay on target or home into target. Interesting psychomotor tasks require coordination of two sets of information, one that is picked up by referencing a sense to some portion of S's environment and one that is picked up by referencing a sense to some portion of S's musculature. We can call both sorts of information perceptual if we wish. However, diagnosing elements of failure that instruction must overcome in such cases inevitably necessitates distinguishing informational sources, whether we class them under one rubric or different rubrics. One can accept that there is no such thing as response information if one then turns around and asserts that relevant information sometimes is perceived by monitoring the motor component of performance.

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